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The Watkins Manual

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PHOTOGRAPHY

EIGHTH
EDITION
1919

THE
WATKINS
MANUAL
OF
EXPOSURE
AND
DEVELOPMENT

BY

ALFRED WATKINS, F.R.P.S.
(Progress Medalist, Royal Photographic Soc. for 1910)

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PREFACE TO SEVENTH EDITION.

Even in war time, when organizing and addressing recruiting meetings supersedes speed testing, there comes again the demand for a new edition. It is once more thoroughly revised, a few items dropped out, and new matter, as Making Time and Temperature Table, Kinematograph, Telephoto, and Colour Plate Exposure, inserted. But the main structure of the book is as of old; it seems to stand the test of time, and continues to bring me in touch with a host of photographic friends.

A.W.

Hereford, February, 1915.

NOTE FOR EIGHTH EDITION.

This is practically a carefully corrected reprint of the Seventh Edition.

August, 1919.

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Outline for Beginners

⁂

This manual has to deal with some of the more advanced branches of photography, such as interior work, copying, enlarging, reduction, intensification, advanced hand camera work, etc. These things have a strange fascination to the beginner, who usually enters into them before he has learnt the A.B.C. of his work.

PRAY YOU AVOID IT. You have just simply to learn the right ways to put a plate in the slide, to point the camera right, to expose correctly by meter, to develop correctly by time, to fix and wash the resulting negative, and to make prints from it. Read—from the commencement—just as much of this book as teaches you this and explains the principles of the tools you are using

Beginners' Chapter

The paper photograph which you know so well—called by photographers a *print* or *positive*—is a final result, and to obtain it you must first produce on some transparent subject—usually glass—an intermediate picture, called a *negative*.

This is in appearance exactly the reverse of the positive, everything that is white in the positive, such as the sky in a landscape, a linen collar in a portrait, being dark or black in the negative.

The negative (fig. 2) is produced on a glass plate (or some substitute for glass) coated with the sensitive substance. At this stage it is called the "plate" or "film."

Sensitive—in photography—means easily acted upon by light.

In order to produce this negative—the first stage towards the production of the finished picture—you must have three essentials:—

The Lens to form the image.

The Plate to receive the lens image.

The Camera to shut out all light except coming through the lens.

Let us consider these more carefully.

The Lens is an optical contrivance which receives the light reflected from the subject and transmits it in straight lines to a piece of obscured glass—called the focussing screen—held at a certain distance behind the lens. If all light is shut out except that passing through the lens, a perfect picture of the object in front of the lens is formed on the screen.

This picture is called the image. It is always upside down, and appears in the natural colour of the object.

It is only sharp when the ground glass is at a certain distance (which depends to some extent upon the distance of objects in front of the lens) from the lens, and this particular distance is called the focus of the lens. When the screen is nearer or farther away from the lens than this point, the picture is blurred or confused, and is said to be "out of focus." In order to make the image sharp all over the plate it is usually necessary to contract the opening in the centre of the lens through which the light comes, and this contraction is called the diaphragm or stop. The rapidity of a lens (or amount of light it passes) depends entirely upon the size of this stop in relation to the length of focus. The lens is provided with means of using different sizes of stops, and in the all-important question, "how long to expose?" that is, how long to allow the light to act upon the plate, the size of the stop has a most important influence. The question of what size (or rather what focus) of lens to buy is decided by the size of plate you select to use; and the general rule is to get a lens the focus of which is equal to a line drawn from one corner of the plate to the other. Thus for the popular size of plate called "quarter plate" the focus of lens will be about 5¼ inches, and for "half plate" 8 inches. If the focus of a lens is much shorter than this diagonal line it is called a "wide angle" lens for that particular plate, but not for a smaller plate which it may be used with.

When a lens is permanently fixed in a camera at correct focus it is called a "fixed focus lens."

A small hole—the size of a pin or needle—in the front of a light tight box will form an image on a plate inside the box without any lens being used, but the illumination is feeble. A picture so made is called a pin-hole picture.

The Plate or Roll Film.—Now-a-days the sensitive plate or roll film (which when "exposed," "developed" and "fixed" becomes a negative) is sold ready prepared. The platemaker has prepared a kind of gelatine soup containing the sensitive silver salt. This he has poured, while warm, on the glass, and put level to set. The plate is now covered with a substantial thickness of jelly, in which are set innumerable particles of bromide of silver, each particle sensitive to light, and if acted upon by light, capable of being reduced or changed by the developer to metallic silver (which in this case is black). Where most light falls upon the plate all the sensitive particles are changed to silver, and the layer of jelly is blackened throughout. Where less light falls upon the plate only a small number of particles are effected, and the jelly is partly obscured. Where no light falls upon the plate (as in the deep shadows of the image) none of the particles are changed. The plate is placed in the camera in such a way that the image formed by the lens falls upon it in sharp focus and a reproduction of the objects in front of the lens is impressed on the plate in the way roughly indicated. The jelly on the plate has been dried into a thin film long before you buy it, but you are more likely to get a correct idea of the production of a negative by thinking of the sensitive plate as a *thickness* rather than as a *surface.*

The plate is sensitive to different coloured lights in different degrees. For instance, the yellow reflected by a primrose has a very small effect, while a blue flower reflects light which is very active. Hence it is that yellow generally comes out dark in a photograph, while blue comes out nearly white. Such colours as red, orange, yellow, and—in a lesser degree—green, have a feeble effect on the plate, and are called non-actinic colours, while blue and violet have a vigorous chemical effect on the plate, and are called actinic colours. If light of every colour had an effect upon the plate, you would have to open your box of plates, put one in the dark slide, develop, and fix it in absolute darkness. But as we know that red or orange light has little effect on the plate, we can do this work in a room lit by red or orange light, every particle of white light being excluded. This is called the *dark room.* *Caution.*—A box of plates or roll of film must only be opened in darkness or by red or orange light, and not a particle of white light (except that coming through the lens to form the image) must fall upon it until after it is developed and fixed. The faintest gleam of white light from a crack in the window shutter or under the door would spoil the plate.

I have used three terms in connection with the plate not yet explained. To expose is to place the plate in the camera and to allow the image formed by the lens to fall upon it. The *time* the light is allowed to act is called the exposure, and no alteration is visible on the plate, as the light does not darken the sensitive particles, but changes them in such a way that a chemical solution called the developer will change those particles acted upon to black silver, and so darken the plate. To develop is to pour the developer on the plate (in the dark room). Fixing is a process which follows development; a fixing solution which has the power of dissolving all the sensitive particles not acted upon by the light is poured over, leaving only the deposit of silver which forms the image.

All these principles apply when a celluloid or other film instead of a glass plate is used, and the word "plate" will be used throughout this book to signify the sensitive film and its support, whether such support be rigid or flexible.

The Camera.—The chief function of this is to shut out all light except that which passes through the lens. If it were not for the fact that the plate sometimes wants moving a little nearer or farther from the lens in order to get some particular object "in focus," the simplest box would do for a camera. But in order to focus, a sheet of ground glass (called the focussing screen) has to be placed for a time in the exact place occupied by the plate, and the back of the camera must be capable of movement. The plate is not put loose in the camera, but is enclosed in a thin frame or case closed with light-tight sliding shutters which is called in England a dark slide, in America a plate holder. Each dark slide holds two plates, back to back, and a set of 3 is considered the usual number for a camera, so that the photographer may carry with him 6 plates ready for use. The dark slide fits the back of the camera and takes the place of the focussing screen.

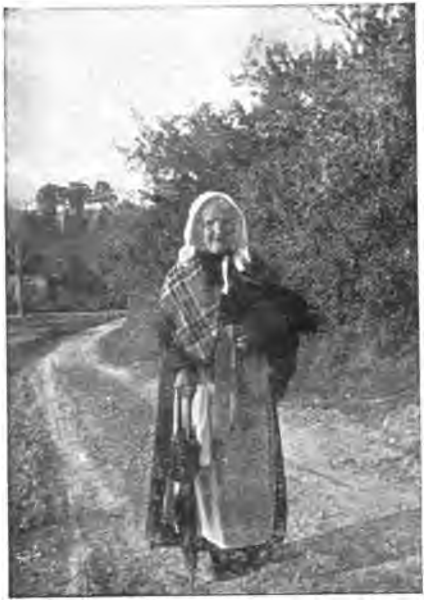


Fig. 1.
Positive or Print

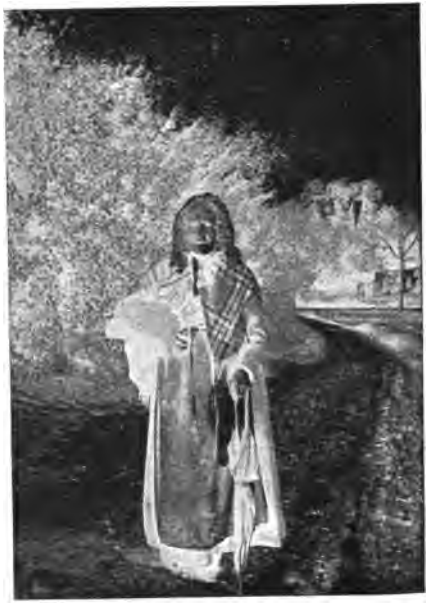


Fig. 2.
Negative

Face Page 10.

The above descriptions apply to those cameras designed for use on a stand; a hand camera usually has no focussing screen, and the arrangements for changing plates or winding up the rollable film are different to that described.

Apparatus

(At this point the beginner who has already purchased a hand camera should pass on to the Snapshot Beginner's Chapter, page 19.)

To Commence Photography.—It is a capital plan (advocated by Mr. Ethelbert Henry) to commence by learning to print. Procure a quarter-plate negative from a friend or professional, and learn to print from it. You thus begin the easiest branch, at a small expense, and have some idea of what is required in a negative before you begin to make one.

My own beginning was with a spectacle glass for a lens, and a camera built out of a cigar box, and I had mastered many difficulties before I advanced to a more complete apparatus.

If you are animated with a similar spirit I should advise you to make for yourself a pin-hole camera, with which, without a lens, you can get excellent pictorial results. It is of no use for figure subjects, the exposure being so long, but for landscapes and buildings the results are usually preferred by artists to the acutely sharp definition given by a lens. But in case you wish to proceed at once with a more orthodox apparatus, I give advice accordingly.

Size of Apparatus.—First decide what *size* of picture and plate you wish to adopt. The plates in use vary from the quarter-plate (4¼ x 3¼) to 15 x 12. Not only does the cost of apparatus greatly increase with larger sizes, but the cost of every plate exposed becomes a consideration. Practically, I should advise you to choose between "quarter-plate" and "half-plate" (6½ x 4¾).

The first is, on the whole, the most advisable, and it is really the most convenient size if you are likely to want to make lantern slides. Half-plate is the favourite amateur size; it is just large enough to make a respectable-sized picture. If you are going in to photograph from the landscape pictorial point of view, caring nothing for portraits, a plate 7½ x 5 is perhaps the best. It is my own favourite size, and is practically the largest size that a man of average strength can carry on a long day's tramp. If you are interested in stereoscopic photography you should specially select a make of half-plate or 7½ x 5 camera, in which the front is wide enough to take a pair of lenses. Most patterns have too narrow a front for this.

What to Buy.—You will want lens, camera, stand, and plates (I will consider developing apparatus under a separate heading).

The first rock for a beginner to steer clear of is the temptation to buy a hand camera. Now it is a common illusion to suppose that a hand camera in some way simplifies photography. It is merely a camera specially designed for one limited and rather difficult branch of photography —quick or instantaneous work; a branch that no one should attempt until he or she has become fairly well grounded. I should explain that an instantaneous photograph is one in which the lens is uncovered for only a fraction of a second (usually between 1-15th and 1-100th) so that when moving objects are photographed, the movement does not cause the image on the plate to be blurred. The lens cannot easily be uncovered and covered again so rapidly by hand, and a contrivance called a shutter is used for instantaneous work. For this special work it is convenient to have a camera which is always set to focus, which can be held in the hand, and in which the plates are quickly changed; this is a hand camera.

It may be roughly asserted that good instantaneous pictures cannot be taken in England from October to March (snow or seascapes excepted), the light not being good enough, that any objects not actually moving are better photographed by a camera fixed on a stand, exposing by hand, not shutter, and that for one moving object the average amateur will want to attempt he will have nine still objects (portraits included). It is a mistake to buy either a hand camera or an instantaneous shutter to commence with, and if the camera you get is fitted with a shutter, you should put the shutter out of sight for the present. These objections do not apply to photographers with experience.

Lens.—There are three chief types, the Portrait, the Doublet or Rapid Rectilinear Anastigmat, and the Single Landscape. The Portrait lens is only wanted in the rather poor light of a studio, and is quite unsuitable for out-door work. The choice lies between the other two types.

The double lens can be used with the largest opening, and is the best for instantaneous work. It also gives upright lines to any upright object which happens to fall at the margin of the plate, which a single lens does not. The single lens answers every purpose except for the most rapid work, and for architecture and copying. If expense is a consideration, I should certainly advise the selection of a single lens, as a cheap single lens is often of first-rate quality.

If you can afford to buy a lens by one of the best makers you will not want help in selecting, as you will be sure to get a first-rate lens.

If you buy a cheap lens, get some photographic friend to try it for you before purchasing. A fair proportion of the cheap lenses are every whit as good as R. R. lenses by the best makers, but they want picking out. Remember that the lens is the most important part of your outfit, the camera is of little importance in comparison. A lens has to be fitted with some form of stop or diaphragm; adjustable as regards size, for cutting off outer rays. The modern and most convenient method is a mechanism called the iris diaphragm. The modern anastigmatic (or stigmatic) lens is a great advance on the best rapid rectilinear, and in the quarter-plate size is well worth the small extra cost.

Camera.—Select a modern folding bellows body camera, with rack and pinion and rising front, fitted with swing back and three double backs. Avoid the extremely light patterns, or those plastered all over with leather or imitation leather, and remember that expensive cameras are merely luxuries, and that a given lens takes exactly the same picture if screwed to the cheapest camera as it would when worked with the most expensive. Do not buy a shutter to begin with; it will only cause you to waste a lot of time and plates in attempting instantaneous work before you have learned the rudiments of the art. You will want a focussing cloth —a yard of cotton velvet is about right for a quarter-plate camera.

Stand.—This, of course, will be of the portable tripod form, with a triangular head, unless a turntable is provided. A two-fold is better than a three-fold, and sliding legs are by no means necessary. That form of fold known as the "rule joint" is the firmest, cheapest, and best. A brass thumb screw fastens camera and stand together.

Plates. —These are always bought ready prepared, in boxes of one dozen. It is very rare for any maker to sell really bad plates, and no special advice is needed as to choice of maker. Plates vary in speed, and if 1 second exposure is right for taking a photograph under certain circumstances with an "ordinary" or slow plate, from ¼ to ⅛ second will be right for the quickest brand of plate with the same conditions.

Most makers turn out 3 or 4 qualities — namely, Ordinary, Studio or Portrait, Rapid, and, finally, Excessively Rapid.

The most rapid plates do not, as a rule, give an image of such good quality as the Ordinary, and are more difficult to manage in development. My advice is to begin with Ordinary or Rapid plates, and never—even when you get more experience—to try the Studio or Excessively Rapid qualities. Even when you come to make shutter exposure (and I hope you will put it off for a long time) never use plates of extreme rapidity. There are also plates called Isochromatic or Chromatic, which give a more correct rendering of the scale of colours, being more sensitive to green and yellow. The Ordinary plate of to-day is quick enough for most purposes; it is 20 or 30 times as rapid as the wet collodion process which represented the utmost speed of 25 years ago.

Dark Room

I have already explained that it is necessary to go into a darkened room or one lit only by red or orange light to put a plate in the slide or to develop it. The provision of a dark room is the amateur's chief difficulty, but it is simplified if thermo development is adopted, as in that case no dark room light need be provided, as it is easy to do the required work in the dark with a little practice.

The simplest way is to wait until night, and then do your work in the back kitchen or bath room, or other available place; one provided with a sink if possible.

Another way is to find some room, or even large cupboard or space in the cellar which can be given up to this sole purpose, and from which every particle of white light can be shut out. This room can have a window covered with orange glass, paper, or fabric for daylight use, or all daylight can be shut out and a dark room lamp used. If the room is lighted by one window, make a frame of wood the size of the window and cover the upper part with black American cloth and the lower part with two thicknesses of orange fabric or paper (to be had from a photographic dealer). Remember that the fabric or paper will fade in a little over a year's exposure to daylight, and will have to be renewed. If you are likely to work most at night, cover the whole of the frame with American cloth, and use a dark room lamp. But if you can possibly arrange so as to have the lamp (or gas jet) *outside the room* which it illuminates through a window of orange glass, fabric, or paper, it will conduce to your comfort. A sink to carry off waste water is a great convenience, and can be made out of a strong wooden box well pitched inside. A plain table (which you are not afraid of spoiling) should stand close to the sink for developing on, and a water tap over the sink is the height of luxury. If this cannot be done, you must bring water in a can, and if a sink is also impossible, a bucket or pail must take its place. Shelves for bottles, measures, and dishes are desirable.

You will probably have to buy a dark room lamp. Get one as large as possible. I once made a wooden frame, a foot square and 18 inches high, to stand round a paraffin lamp; the top had a tin cowl like a magic lantern and the bottom had ventilation slits masked to keep light from passing. The sides were covered with orange fabric. two thicknesses. Orange or red paper can be had from a printer, orange fabric from a photographic dealer.

The other dark room fittings required will be:—

One developing dish, the size of the plate.
One fixing dish, double the size of the plate.
One toning dish, " " .
One washing dish, " " .

I should advise all dishes to be of granitine, ***deep;*** do not get shallow ones or the ordinary porcelain. Some prefer celluloid for the developing dish; it is lighter in weight.

A cover for developing dish.
One minim measure glass (10 to 120 minims).
One 2 oz. measure glass.
One 4 oz. " " (one of the small ale glasses mentioned in JOTTINGS may be substituted for this.)
A glass jug. holding a pint or over. and marked with a file at the level of 10 and 20 oz., is useful (you can gauge this with the aid of your 4 oz. measure.)
A scale for small quantities (there is a convenient one with one glass pan which stands on a foot and is sufficiently accurate; it costs 1s. or 1s. 6d.)

If you can possibly manage it have a separate shelf or small table for the fixing dish and solution on the other side of the sink to the developing table, as the slightest trace of fixing solution causes stains before or during development. If you cannot do this, keep the fixing dish at the other end of the table to the developing.

A Lesson with the Camera.—Unstrap and open the tripod legs, fasten them to the tripod head. Open out and set up the camera (the method of doing this varies with different makes) and fasten it by the brass camera screw to the tripod head. Screw the lens in the front of the camera. See that both front and back of camera are upright, that is at right angles to the base. Go out of doors and set the camera in front of a tall building. Notice that the base board is level, that the camera is not tilted in either direction. The lens should be fully open (not a small stop in). Put the focussing cloth over your head to shade the focussing screen while you examine the image; it is probably blurred and indistinct. Turn the brass milled head on the right hand of the camera backwards and forwards (moving the lens to and from the back) until you find a point where the image of a near object on the focussing screen (which, by the way, is always upside down) is quite sharp and distinct. This is called focussing. Now notice whether what you want included in the picture is to be seen on the ground glass. It is most probable that you don't get enough of the top of the building. Raise the lens by the rising front, and look at the screen again; more of the top of the building will now be shown and less of the ground. If the building seems to fill up the screen too much and you can't get it all in, you must move your camera farther away. If with this rising front fully raised you still cannot get the top of the buildings on the screen, you may have to tilt the camera so that the lens points slightly upwards. When this is done it is absolutely necessary to use the swing back adjustment or the upright lines of the building will appear on the screen to converge towards the top.

In adjusting the swing back the golden rule is ***keep the focussing screen plumb upright.*** If this is done the picture on the screen will be upright. After adjusting the swing back you will have to focus afresh. It sometimes happens that you cannot get far enough back from a building to include all you want on the focussing screen. If you had a lens of *shorter* focus it would include more of the subject from the same point, and this lens would be (for this size of camera) a wide angle lens. But you will do very well without one for a long time. With the lens full open you will probably notice the image on the screen is not quite so sharply defined at the extreme corners as it is in the centre. Put a medium size stop in the lens, or turn the iris diaphragm until the aperture is smaller. The picture on the screen will be much darker, but the definition at the edges will be sharper. This is why stops are used.

Always keep the camera exactly level, and the swing back square with it; unless you cannot get all your subject in by raising the front, in which case the camera may have to be tilted a little from back to front. But there is no exception to the rule that the camera should always be level from side to side.

Filling the Dark Slides.—Go into the dark room, open a dark slide, open the box of plates, take one out, the film side is the dull side, but if you have the slightest doubt, place a corner between the wetted lips and the film side will stick a little. The plate should be carefully dusted, the palm of the hand (or rather the lower part of the thumb) is a safe implement, if the skin is not moist. Put the plate in the slide with film side outwards, that is towards the outer slide. Repeat with the next plate. When the slides are filled close up the box of plates.

If you ever use more than one brand of plate, make a note of the name of the plate in the exposure columns of your note book in such a position as to come opposite the lines in which the exposure will be recorded. This will be both a memo. of what plates are in the slides, and a guard against exposing twice over, for as each plate is exposed. the particulars opposite it will record its being used. The use of exposure note book as a record of exposure is most important. The one sold for the Watkins methods contains space for entering particulars of development and results.

Note.—Plates can easily be put in slides or changed *in the dark,* working by touch. A candle should be carried in first, and the plates and slides arranged ready. Speaking personally, I never trouble to carry a portable red lamp when touring.

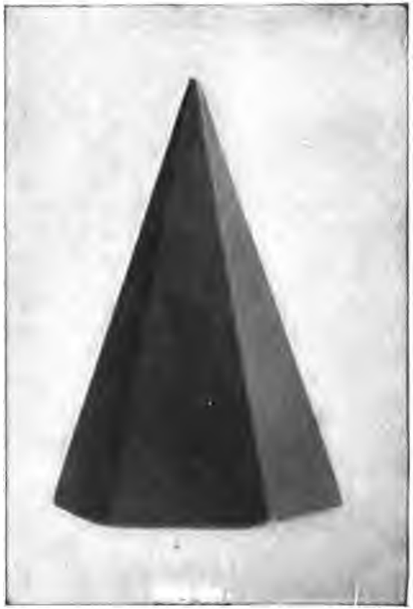


Fig. 3
Positive

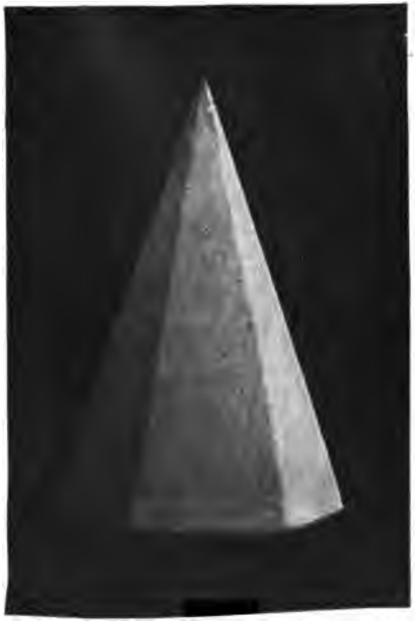


Fig. 4
Negative

Showing four simple tones or steps of gradation.
See page 25.

Face page 18.

Snap Shot Beginners' Chapter

(For those beginners who have already decided to commence with a hand camera.)

Two Golden Rules.

A HAND CAMERA IS A TOOL, NOT A MACHINE.

SNAP SHOTS ONLY SUCCEED OUT OF DOORS, AND IN BRILLIANT LIGHT.

Snap Shot or Stand.—You must at the outset grasp the two broad divisions of work. Firstly, those occasions on which the light is good enough for a short exposure, called a snap shot, to be given; and secondly, those in which a longer exposure (so long that the hand cannot keep the camera steady for the time) is absolutely necessary.

A Hand Camera is chiefly intended for the first class of work, but it is always practicable to use it for the second, for even the simplest box camera can be used on a stand, or set on a shelf or table, or held against a wall or post, while a stand or time exposure is given.

The possession of the "cutest camera," and the desire to snap everything, will not alter the stern fact that only a minor proportion of desirable subjects are well lighted enough to be snapped with success.

If you care to limit yourself to outdoor summer work on bright days only, you need only think of snap shots. But if your aim is a wider one, including indoor and portrait work, you MUST give stand or time exposures on occasions. We will deal first with snap shot work.

Limits of Snap Shot Work.—First, as regards light. A plate or film requires a certain duration of light action through the lens to secure a picture, and if this necessary duration is more than say 1-10th second, the camera cannot be held steadily for the time. Thus with a poor light and towards evening the necessary light action may be ½ second, and if the usual snap shot provided in the camera (probably 1-30th second) be given, the plate or film will be under-exposed, that is, it will come out imperfect and worthless when developed, for no amount of skill in development can improve it. Hence your chief limit of work is one of LIGHT. With fairly cheap hand-cameras the single lens, with a full opening of about F/12, requires sunshine, or sun lightly covered with clouds, and the SUMMER HALF OF THE YEAR. This necessary amount of light is about A4 on Watkins Meter, and snap shots in light worse than this, or when the sun is low in the evening, are wasted.

With a double or R. R. lens, the opening (stop) in lens is larger than in a single lens, usually F/8, and light down to A8 on Watkins Meter can be used, say Winter sunshine or slightly dull (not very dull) light, in Summer will suffice.

F/12 means that the width of the lens opening through which the light comes is one-twelfth the distance from lens to plate (the focus). F/8 is a larger opening, being one-eighth the focus.

Some cameras have slow speeds down to 1-16th or even 1-8th second, and then snap shots can be taken in still poorer light, extra pains being taken to hold the camera still. Again the use of modern plates of excessive speed (usually coarse in grain and poor keepers) still further extends the possibility of snapping in poor lights. A Watkins Bee Meter (or Focal Plane Meter) will instantly tell by actual test whether the light is good enough to take a snap shot under all these varying conditions. See page 58.

Making Snap Shots.—First take stock of HOW FAR YOU MUST STAND AWAY from your subject. Ask someone to stand, and see how he looks on finder of camera at 4, 6, 8, and 12 yards away. Make the same trial with a building (at longer distances), and if too near, you will find the object not all included; if too far away it will be too small on plate. You cannot work without some aptitude in judging distances, therefore learn to judge the right distance for a figure or group of figures to be the right size on your plate. Also read "Objects in Focus," and understand that unless your camera is a focussing one you must stand at something more than a minimum distance, in order that your nearest object may be sharply defined on your plate or film.

See that the camera is loaded with plates or film ready for use.

Hold the camera firmly in both hands, as level as if it were a bowl brim full of water. Never point the camera upwards, it will make buildings appear tumbling down. (In those exceptional cameras provided with swing back the camera MAY be pointed upwards if the back is kept perfectly upright). If a tall building is included, raise the rising front if there is such an adjustment.

Just before snapping draw a deep breath, and hold it as you "press the button"; this prevents shake. The snap should be made with a firm and deliberate pressure as between thumb and finger, not by a sudden dig.

Attention to following four points has advantages over merely looking at the finder:—

1. Face subject squarely, and direction will be right.
2. Hold camera level, and elevation will be right.
3. Stand at right distance, and amount of subject on plate will be right.
4. Fix your eyes on your subject, and the moment of snapping will be right.

Personally, I think that you will attain greater success if you attend to these points, and do not look at finder, except perhaps a little before exposing, to help you in judging amount of subject included.

See that the subject is worth having before you snap.

Distant views and wide landscape are not effective.

The sun must not shine on glass of lens when snapping. If sun is to one side, or even towards front, the picture will be far more effective than if exactly behind, for a proportion of shadow in a picture is desirable.

A group with people staring straight at the camera is horrible; do all you can to prevent it. In a street view if people are staring at you, wait until their attention is directed to something else.

Objects in Focus.—Focus is the exact distance between lens and plate to make the objects sharply defined.

A hand camera (with its lens) is often called "fixed focus," because it is (or ought to be) so adjusted that a group of people at a distance to be a suitable size on the picture is in sharp focus. Anything much nearer than this will be slightly blurred or "out of focus," and anything much further away may possibly be not quite sharp, although this does not matter in the distance or background. Cameras with "racking out" focussing adjustment can be used for much nearer objects, but those with "fixed focus" can take nothing nearer than a standard distance, which varies with the focus of the lens. For instance, a portrait head or bust requires to be nearer than this standard distance, and cannot be sharply photographed with a fixed focus camera unless a "magnifier" sold for the purpose is used. Of course the fixed focus cameras can be used for all distances greater than this standard distance, which with a quarter-plate camera averages about 15 feet (five to six paces).

It is an error to apply the word "fixed focus" to a lens, as all lenses are equally fixed focus.

Variable Speed Shutters (if provided).—High speeds, say over 1-100th second, are only wanted for very rapidly moving objects, such as bicycles or trains. For usual movement of people in a street, the usual speed of 1-40 or 1-50 second is quick enough not to show movement. The object of using *slower* speeds is to get sufficient exposure in a dull light, and down to 1-16th second will do for grazing animals, or ⅛ for people in groups. The slowest speed your subject permits should be used.

There is no danger (inland) of getting serious over-exposure.

Focussing Adjustment (if provided).—Before using this with the scale marked on the camera you MUST practice judging distances.

Stop or Diaphragm of Lens.—If small stops are provided, you will not (unless for sea views in best light) want to use them for snap shots. They will come useful for "time" exposures. But with a lens with opening greater than F/8 (an expensive modern lens) the F/8 should be the usual opening for good light and the full opening kept for poor light. A small stop tends to give sharp definition in near and distant objects alike.

Plates and Films.—Use rapid plates, but not the excessively rapid top speeds for the present. With films you are safe with the excellent standard brands of good repute.

Re-filling Camera.—Must be done in a "dark room." Take care that the sensitive film side of plate comes towards the lens. It can be told by feel or sight as slightly dull and matt, while the insensitive side is slick and glassy. With films do not shirk reading the makers' instructions for changing. Exposed plates (if not to be developed at once) must be packed up carefully face to face, and wrapped in paper in a spare plate box, in the same way as the unused ones were found.

Chief Causes of Poor Snap Shots.

1. Light not good enough. Result—poor detail, or misty-looking picture.
2. Camera not level (pointing upwards). Result—tottering buildings.

And although development is not here treated, it is impossible to overlook:—

3. Negative over-developed. Result—hard soot and snow appearance.

Stand Work or Time Exposures.—To place your camera on a stand, or to hold it firmly in some way, opens up an enormous new field of work which cannot be attempted by snap shot even in summer time. Groups or portraits in the shade, buildings in narrow streets, flowers in the porch or greenhouse, bits in your own rooms, lovely detail in churches and cathedrals, peeps in shaded lanes and woods. In addition to all this, work of all kinds all the year round, even if light is feeble. The camera can often be placed on a shelf or low wall, or held firmly with its side or back against a wall or post, for a time exposure. But of course these plans are makeshifts and a proper stand is best. Your camera will have some contrivance to set it to "time." For time exposures use the smaller stops.

For each set of circumstances (light especially) a different time of exposure is required, and it may vary from half a second out of doors to half-an-hour in a dark church. For this problem or knowing "how long to expose," the Watkins Bee (or Queen Bee) Meter is the beginner's pilot, as it accurately *tests the light* and calculates the exposure to give. It gives help (indoors especially) which the tables and calculators cannot attempt, and as it also gives the information whether the light is good enough to take a snap shot in, the user of a hand-camera can no more afford to do without it, than a carpenter can do without his pocket rule. If your camera is a Kodak, get the Bee with a U.S. dial, on which the small and medium stops are marked, besides those which are numbered on the camera. U.S., by the way, signifies uniform system.

If your camera has sliding stops merely marked 1, 2, 3 (Brownie, Klito, &c.) get a special dial sold for the particular camera marked for its stops only.

For development see page 70, first reading page 15 for dark room arrangements.

EXPOSURE

The Problem.—In front of the camera some object or collection of objects is set. We call one part of it a "high light," because it reflects plenty of light to the eye, another part we call dark or a shadow, because it reflects very little light to the eye. Other parts, reflecting intermediate amount of light we call "half tones." In a real subject, of course, these high lights, half tones, and shadows are much broken up and intricate, blending one into another, but for the sake of simplicity let me put before you a simple object in Fig. 3, with good, broad and distinct lights and shadows, and an absolutely black background reflecting no light at all. It is much more convenient to regard these gradations of light and shade as definite *steps* than as indefinite tones blending one into another. The extremes we shall want to render in a photograph are represented by the white side of the wooden block at the one end of the scale and by the black background at the other end.

Now it is this very same capacity of reflecting light to the eye (the eye immediately making a mental note whether the tone is light or dark) which enables each tone to take its photograph by registering on the sensitive plate the fact that it is either a light or a dark tone.

The light reflected from different parts of the object passes through the lens and falls upon the sensitive plate or film fixed in the back of the camera. The lens is an optical contrivance which keeps the different bundles of light rays each in their distinct path, so that when all fall upon the sensitive surface there is a complete and accurate representation of the object exactly as in Fig. 3. It is this image which is seen when the focussing screen is placed in the back of the camera and looked at with a black cloth arranged over the head. The lens may be regarded as a window to admit the light forming the image to the camera.

If the lens is fully open (used with a large stop or diaphragm) the image is brightly illuminated, but if the lens is partially closed (a small stop used) the image or pic is dull and poorly lighted, but the relative lighting of the different tones remain the same. The image of the object as seen by the eye—as in Fig. 3 (page 16)—and projected through the lens to the sensitive plate is called the

POSITIVE IMAGE,

and the final paper print (usually called the photograph) is also a positive image.

When the highest light of the subject (represented by almost white paper in Fig. 3) is impressed on the sensitive surface it makes a record by (ultimately) darkening the plate to an opaque black, while the black background reflecting no light has no effect at all, and leaves the cream-colored sensitive surface unaltered, or (when the plate is completely treated) as clear glass. It will, therefore, be seen that to represent the subject shown in Fig. 3 a

NEGATIVE IMAGE

is formed on the plate. This is shown in Fig. 4, and is exactly reversed to the other, and is black where the original was white, and white where the original was black. The sensitive plate or film actually in the camera becomes, therefore, when further treated by the process called developing a negative, which is not usually regarded as a photograph but as a printing plate or record from which photographs may be printed.

The success of the photograph depends upon the accuracy with which the various lights and shades of the subject are represented in the negative. It is not sufficient that the outlines of the object are impressed on the negative.

The problem of *Exposure*, with which we are concerned, is entirely directed toward the end that the *different* lights and shades of the subject shall be rendered by *different* densities or tones in the negative. We need not trouble about the outline or definition of the tones, as the optician sees to that.

The Eye and the Plate.—Although there is a certain resemblance between the way in which the light reflected from a certain tone is judged by the eye and the way in which it is recorded by the plate, there is one important difference. The eye records the same estimate of an object whether it gazes on it for a second or a minute. The record on the plate depends, not only upon the intensity of the light reflected, but also *upon the time the light is allowed to act.* For example,, suppose a white sheet of paper were photographed with a correct exposure of, say, one second, and then a sheet of grey paper which reflects only one-quarter the light of the white paper were photographed on another plate with an exposure of four seconds. If both plates were developed for the same time, the two negatives would be identical in the amount of light action recorded, and, therefore, in opaqueness, or—as it is called in photographic language—density. This is the reason why the *time to expose* in such an important question in taking a photograph.

Limits of the Plate.—Let us examine the capacity of the plate for representing (by different degrees of darkening or "density") the different tones of the subject. The important point to remember at first is that its capacity is decidedly limited. In the one direction it is possible to give so short an exposure that although light does fall upon the plate it does no work at all. In other words, there is a *minimum* amount of light action for every plate, and anything below this is of no use. Therefore, to represent on a plate the darkest tone of a subject the light must be allowed to act long enough to attain at least the minimum amount for the particular plate. This is the limit of the *smallest exposure.*

On the other hand, there is a *maximum* amount of light action which is sufficient to affect practically all the silver particles in the plate, and any increased light action greater than this has no increased effect. This is the limit of the *greatest useful exposure.* Fig. 5 (page 24) shows the full scale of tones a plate is capable of giving, the figures giving the relative exposures. Notice that on this plate 96 is the *maximum* useful exposure and 2½ the *minimum* useful exposure.

I have attempted to show graphically how the different tones of a negative ought to come between these extremes. Three negatives (under, correctly, and overexposed) were developed for the same time as the long scale of tones in the same dish. They are placed in position so that the high light (the sky) comes opposite the same exposure on the scale; and a half-tone (a bit of the old lady's dress to the right of her hand) is also opposite its equal exposure on the scale. The short lines indicate these matching points. In the lowest (under exposed) negative all the shadow detail is represented by no light action at all. In the top negative, on the other hand, all the lower tones are correctly represented by *varying* tones, but the high lights come up into exposures above the maximum and are all equal, that is they will all print equally grey or white, which is a sign of over exposure.

The need of "correct exposure" is, therefore, created by these limitations of the plate. The amount of light action which defines the minimum exposure is not the same with all makes of sensitive plates. When it is exceedingly small the plate is a "rapid" one, and when much greater the plate is termed "slow."

Latitude of Plate.—The difference between the minimum and the maximum light exposures is not the same with all plates. With some poor ones the range is so short that to render all the tones in a subject without getting the shadow detail below the minimum and the high light above the maximum requires the exact exposure to be hit upon; and no variation above or below will give good results. But, fortunately, there are many good plates (more often found amongst medium or slow plates than amongst rapid ones) which have a long distance between minimum and maximum. With these it is not only easy to get all the tones of the subject represented between the extremes, but there is plenty to spare, and it is possible on the one hand to lessen the exposure one-half and on the other to increase it four times without getting outside the limits of the plate.

Exposure Considerations

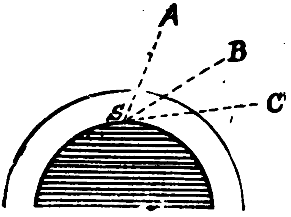
Those who have not skipped the introduction will begin to see that the question of exposure is all important. When a plate is correctly exposed success is more than half secured.

The very general use of snap shot cameras rather tends to obscure this necessity, as the maker has provided (by means of the shutter) a definite exposure, which is usually just sufficient (and never too much, except on seascapes) for summer sunshine and fairly rapid plates. The user of such a camera is left to find out by experience that if he uses it in bad light, the plate is insufficiently exposed. As a matter of fact it is quite as important to adjust the exposure to suit the circumstances when short exposures are given with a shutter as with long exposures amounting to one, two, three, or more seconds.

What Influences Exposure.—There are three distinct influences which determine the time of exposure, viz.:—LIGHT, SPEED OF PLATE, and DIAPHRAGM IN LENS But it by no means follows that with every photograph to be taken these influences or conditions are *all* altered. It is most probable that the same brand of plate will be used for some time, and we will also presume that for the present the diaphragm or stop used in the lens will remain unaltered. For the present, therefore, we will only consider *one* varying factor, and this is one which, unlike the other, is beyond the control of the photographer, and is continually altering. It is the first one—

LIGHT.

All daylight is, of course, derived from the sun, either shining direct on the subject or reflected by vapour or clouds in the atmosphere. In the summer time sunlight is far more powerful than at other seasons, because the s being higher above the horizon emits its rays less obliquely through the atmosphere enveloping the earth. For the same reason the sunlight is more powerful at mid-day than towards sunset. These influences are indicated in Fig. 6, A.S. being the summer mid-day rays, B.S. the winter mid-day rays, and C.S. the sunset rays, the latter passing through much the greater thickness of atmosphere. This influence can be estimated exactly from a knowledge of the time of the year and hour of the day, and if the unobscured sun rays always fell on the subject to be photographed, a simple exposure table would be a complete guide to the variation of light. But the altitude of the sun is only *one* influence affecting daylight, there being two classes of obstructions which interfere with the light falling on the subject. These are, first, Clouds and Atmosphere; second, Physical Obstructions.



Clouds and Atmosphere.—Clouds between the sun and the earth obstruct light, and that in proportion to the density of the clouds; hence we speak of the day being dull or very dull. But clouds also act as reflectors, and on many days when the sun is obstructed they are thus secondary sources of light. Probably the most brilliant days in summer are those in which the sun shines at intervals between white fleecy clouds, and an object receives both the unobstructed sun rays and also light reflected by white clouds from every part of the dome of the sky.

At times vapour or fog in the atmosphere greatly alters the colour of light and lessens its chemical or photographic force. Such a change is difficult to detect by eye, which can only estimate brightness and not chemical—or as it is called—actinic force.

Physical Obstructions.—An object set out in an open plain with the whole dome of sky illuminating it receives the maximum amount of light. Anything in the way of trees, building, roof, wall, or mountain which cuts off any part of the sky reduces the light, and tends to increase the exposure required. This is a far more important influence than might be supposed. Fig. 7 illustrates the subject S on an open plain the angle of light illuminating it being shown by the dotted lines. Let us suppose a wall is built on one side of the subject, and we see by the dotted lines in Fig. 8 that almost half of the light is obstructed. (We are presuming that the sun is not shining.)

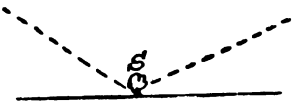


Fig. 7

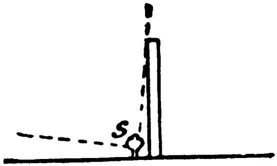


Fig. 8

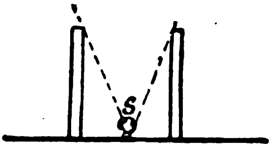


Fig. 9

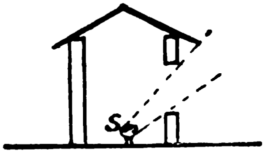


Fig. 10

Let another wall be built on the other side of the subject (Fig. 9), which is now only illuminated by a narrow strip of sky, and the light proportionately lessened. This explains why instantaneous work in streets is not always so successful as in open country.

In Fig. 10 we presume that a roof has been built over the walls, and the only illumination reaching the subject S comes through a window. The volume of light is now enormously lessened, and to secure a correct exposure probably two or three hundred times the exposure must be given for that required under the conditions of Fig. 7.

It will now be seen why views under trees, near buildings, in porches, and indoors require much longer exposures than open landscapes. Much confusion has been caused by treating this matter as a variation of *subject,* whereas it is simply and purely a variation of *light.*

In the earlier days of photography the alterations in exposure made necessary by the variations of light I have enumerated were decided by individual judgment only. A photographer having found by trial a certain exposure to be right with one lighting, estimated that a longer or shorter exposure would be required with a certain change of light.

Later on an attempt was made to help by means of "Exposure Tables." With these a correct exposure for unobstructed mid-day summer sunshine was fixed upon and then variations were tabulated (A) for the altitude of the sun as fixed by the month and hour of the day, (B) for the state of the atmosphere as defined by the vague terms "bright," "dull," and "very dull," and, finally, (C) for the various physical obstructions to light caused by trees, buildings, roofs, etc. These obstructions were allowed for by an attempted classification of "subject" which was hopelessly inadequate when interiors came to be dealt with. Take for instance church interiors. One with large windows glazed with colourless glass might be sufficiently exposed in three minutes, while in the choir of another lighted only by small stained windows three hours would be required with the same diaphragm and plate.

How to allow for Light.—There is no doubt that a few gifted photographers can, in most cases, instinctively judge the power of the light falling upon the subject. But the majority are unable to do this with any certainty. Fortunately, a test with a simple instrument called an actinometer will accurately give the value of the LIGHT WHICH FALLS UPON THE SUBJECT, and the *one* test will allow for month, time of day, clouds and atmosphere and physical obstructions caused by the variation of subject. The actinometer (or exposure meter, as it is called when combined with scales) has a strip or disc of paper which is sensitive to the same kind of light as the sensitive plate. This paper darkens alongside a painted standard tint, and it is found by experience that the time required for darkening to the standard tint indicates accurately the photographic power of the light illuminating the subject. In other words, the camera exposure will always be proportionate to the actinometer test, while the same speed of plate and the same diaphragm of lens is used. There are many reasons why a simple actinometer test is more reliable than judging the value of the light by the eye. One is that light which has a yellow tinge (as towards sunset or in fog or east winds) may appear *visually* bright, but is *actinically* (or chemically) feeble. Another reason is that the pupil of the eye automatically accommodates itself to different degrees of light. We pass from the open air into a room which we call well lighted, and the eye does not give much information as to the enormous difference between the light in and out of doors; probably one to one hundred. The actinometer will give it with fair accuracy.

In my system of exposure, therefore (which was original when introduced by me, although copied since), the keynote to the whole plan, and the golden rule is to

TEST THE LIGHT WHICH FALLS UPON THE SUBJECT,

and this rule applies to practically all cases in which a camera is used, and even for copying, enlarging, and photomicrographs where a condenser is not used. The standard for the actinometer is that it darkens to its standard tint in *best light* (that is, unclouded mid-day summer sunshine in England) in two seconds, and the darkening time in less active light will be in direct proportion to the altered time of exposure required. Suppose that a certain brand of plates is tried out of doors in a rather poor light, and the correct exposure is found by trial to be three seconds. The light has been tested by actinometer (or exposure meter) and requires 12 seconds to darken to tint. Using the same plate and the same diaphragm in the lens the exposure will always in future be *one-fourth the actinometer test.* In summer sunshine, the A test only taking two seconds, the required exposure will drop to ½-second. In the shades of a wood, the A test indicating 120 seconds, the exposure will have to be increased to 30 seconds. In a church interior the actinometer may require, say, 40 minutes to darken to the standard tint, and the correct exposure for the plate will still be one-quarter of this test time, viz., 10 minutes. In the last instance it is obviously a waste of time to occupy 40 minutes in a light test when the right exposure is so much less, and I have, therefore, devised a plan of using a lighter tint in the actinometer, and the light test and camera exposure are made at and for the same time.

It will be seen, therefore, that this *one* test with the actinometer fully allows for *all* the variations which the exposure tables classify as month, time of year, time of day, state of atmosphere, and (to a great extent) subject.

If we always use the same size opening in the lens and the same plate the light test will accurately indicate the variations required for exposure, with a few exceptions (which will be enumerated) for exceptional subjects, copying and enlarging. The beginner who wishes to master the subject of exposure is strongly advised to keep to one diaphragm and one make of plate for some time. But in practice, photographers do not keep to one make or speed of plate, and they also vary the diaphragm or opening of the lens, and these influences must therefore be considered in a complete plan of exposure.

Speed of Plate.—I have mentioned that with every plate there is a *minimum* and also a *maximum* light action. In comparing two plates, A might require double as much light as B (or what is the same thing double the time of exposure) to attain the minimum light effect. B is, therefore, said to be twice the speed of A. If the speed of A were called 40, that of B would be 80, the highest number being always the highest speed. But it must be kept in mind that the exposure required will vary *inversely* in proportion to the number, and the higher the number the less the necessary exposure. The only systematic and reliable method of speed testing at present is that devised by Messrs. Hurter & Driffield, but as those who test by this plan do not use the same standard of light, a box of one maker's plates marked H & D 100 is not of necessity the same speed as another maker's plates also marked H & D 100.

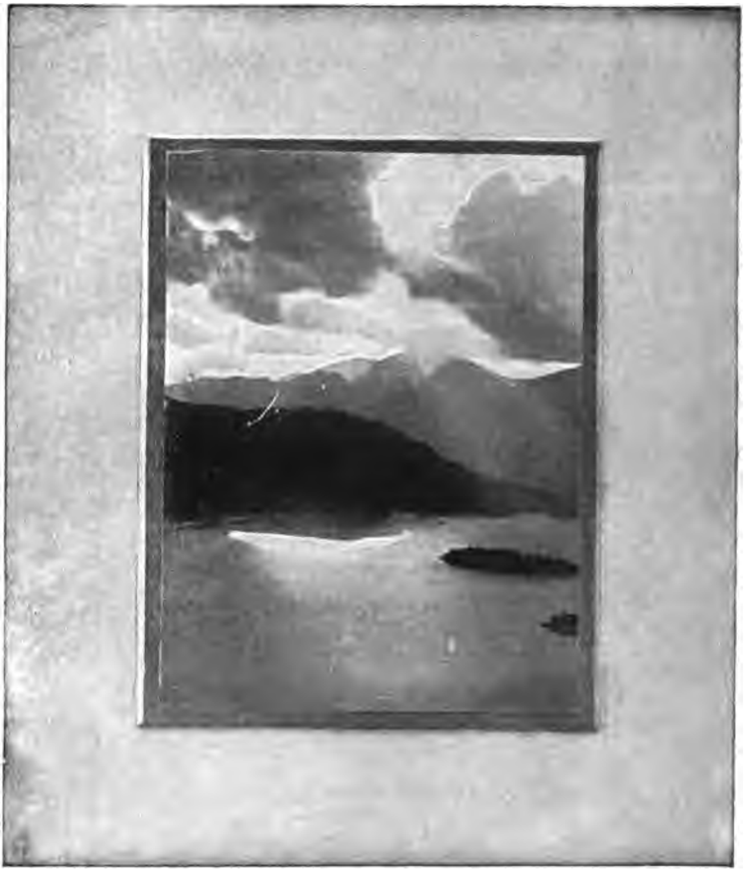


Fig. 11.
Stormclouds, over Derwentwater. The sky was shaded during part of exposure.
See page 45.

Face Page 84.

Although as a rule makers state the relative value of different brands of their own plates, they give no information as to the relation of speed to other maker's.

The Watkins speed card, first issued in 1890, is a speed list of all maker's plates and films, giving from actual test their relative speed, and is frequently corrected. It now gives also the development speed.

A standard of speed has to be adopted, and the Watkins standard for P1 is that with full mid-day summer sunshine in England, and a lens opening of F/8, two seconds exposure is correct. As the actinometer test with the Watkins meter also takes two seconds in full summer sunshine, P1 would always require with F/8 the same exposure as the actinometer time, even in dull or winter light. Practically no plates are sold for negative work as slow at P1. They vary from P11 to P500.

A speed number is no indication of the quality of a plate. As a rule, slow or medium plates are more likely to be of high quality than fast ones, and it sometimes happens that a maker's rapid plates are very inferior to his slow ones—that is, they are incapable of rendering a wide range of tones; and are, perhaps, liable to fog at an early stage of development. But this is not an invariable rule, and poor, foggy plates are known amongst the slow brands, and the most rapid plates are sometimes free from fog and capable of a wide range of tones.

But, on the whole, I should say most emphatically that an extremely rapid plate (say over P180) should only be chosen when instantaneous pictures under trying circumstances are required, or for special indoor work. A plate of highest speed should *not* be selected for general work.

With H & D and Watkins Speed Numbers, the exposure is always inversely proportionate to the numbers, that is, if speed 50 requires one second exposure, speed 100 will require ½-second. But with other speed markings used in England (Warneke and Wynne) the numbers have not this simple arithmetical ratio.

It is unfortunate that although a speed list only claims to give accurately the results of individual tests by one photographer of the particular boxes he has obtained; almost every user of the lists presumes that it claims to be an accurate relative speed list of every box issued by the makers named. To illustrate how impossible such a claim would be, I may mention that in testing two boxes of the same brand of plates, one has been found to be double the speed of the other.

It is peculiarly unfortunate that makers in some cases make speed numbers an advertising matter, and feel bound to keep up the fiction that their particular brand is higher in speed than anything else. It cannot be to the advantage of either maker or user, that the latter should spoil good plates by underexposing, from the idea that they are extremely rapid when, perhaps, they are a good medium speed.

Diaphragm of Lens.—The opening in the lens, or the "stop" as old photographers called it, has a most important influence in exposure. The larger the opening the greater is the flood of light reaching the plate, and, therefore, the shorter the required exposure. The rule is that the exposure varies inversely in proportion to the *area* of the opening. As the area of an opening is proportionate to the square of its diameter, it follows that an exposure varies inversely to the square of the diameter of the opening. In order that the light passing capacity of one lens may be compared with another, it is usual to give the lens opening (or diaphragm) as *a fraction of the lens focus.* Thus the full opening of most R.R. lenses is one-eighth the focus, and the value of this is marked as F/8. The next sized opening is usually arranged to be half the area, so as to require exactly double the exposure, and this is commonly called F/11 (to be exact F/11-31).

In the following table of diaphragms the figure following each indicates the *relative* exposure, taking F/8 as 1, and the alternate figures are those which are usually adopted and which are the standard apertures of the Royal Photographic Society:—

D
value.
F/4 = ¼
F/5 = ⅜
F/5.6 = ½
F/7 = ¾
F/8 = 1
F/10 = 1½

D
value.
F/11 = 2
F/14 = 3
F/16 = 4
F/20 = 6
F/22 = 8
F/28 = 12

D
value.
F/32 = 16
F/40 = 24
F/45 = 32
F/56 = 48
F/64 = 64

Almost all lenses have either iris or wheel diaphragms marked with some of these values, and F/8 of one lens has practically the same exposure value as F/8 of any other lens, even if of different make and focus. (See also table at end.)

By taking away the front lens of a double or R.R. lens the back lens can be used as a long focus lens for a narrow angle view, the focus being double that of the complete lens if the combination is a symmetrical one. The F/-values marked on the mount must in this case be doubled, thus:—F/11 is now F/22, F/16 is F/32.

To find the value of a diaphragm of a single lens. Draw a line on paper the exact length of the focus of the lens, this being ascertained by measuring from lens to plate when the camera is focussed on a distant object. Carefully take the diameter of the diaphragm with the points of a pair of compasses. See how many times this steps into the line you have drawn. If 10 times, the stop is F/10; if 14 times, F/14, and so on.

For double (R.R.) lenses the *effective aperture* (not the actual stop) is measured in the following way (given by the Royal Photographic Society):—"The lens shall be focussed for parallel rays; an opaque screen shall be placed in the principal focal plane, the plate being provided in its centre (in the axis of the lens) with a pin hole, an illuminant shall be placed immediately behind the pin hole, and the diameter of the beam of light emerging from the front surface of the lens shall be the measure of the effective aperture."

Calculating an Exposure

I have shown that the value of the three principal factors affecting an exposure, viz., LIGHT, PLATE, and DIAPHRAGM, can be expressed in figures, and that the value of the figures directly express any required alteration of exposure. It therefore follows that any change of exposure rendered necessary by a change of one or more of the factors can be accurately estimated by simple arithmetic if the correct exposure under one set of circumstances is once known. The rule with the standards of value I have given is as follows:—Multiply the diaphragm value (the D value in preceding table) by the light (actinometer) value; divide by the plate speed to give the exposure.

To express this by symbols $DXA/P = E$.

This can be modified to $D/P \times A = E$.
When an actinometer without mechanical scales is used this little calculation must be done in the head, but there is no need to do it each time, for while the same stop and the same plate is used the exposure will always be an unalterable fraction of the actinometer time, and this fraction is found once for all by placing the diaphragm value at the top and the plate speed below, the D value being found in the table of stops.

Thus:—If you are using F/32 (D number being 16) and could also use a plate of speed 16, the exposure would always be the same as the actinometer time. But you are *not* using such a slow plate, but one of speed 65. This gives the fraction 16-65, and the exposure will always be 1/4 of the actinometer time.

In the Watkins exposure meters this calculation is done by a simple slide rule or set of slide rules, so arranged as to do it in the easiest possible way.

Variations for Special Subjects.—Besides the three influences which I have mentioned, there is a fourth —the colour or character of the subject—the value of which sometimes changes and influences the exposure. In my original exposure meter I provided a special scale for the subject which had to be set each time of using the meter. The standard value for average subjects was set at 100, and special ones at lower numbers down to 10 for cloud negatives.

But experience soon showed that in nine cases out of ten the standard subject value is used, and that the more convenient way is to omit a special setting on the meter for the subject, and to presume that it is of average value; only making a variation from the calculated exposure when exceptional subjects are photographed.

For all subjects of average colour, such as landscapes, foliage, trees, buildings, portraits, groups, ordinary rooms, church and other interiors, groups of flowers, etc., the calculated exposure will be right without variation.

TABLE OF SPECIAL SUBJECTS.

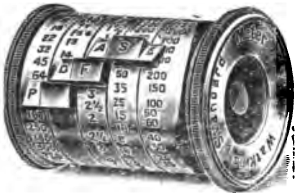
Sky or Sky and Sea: S10 or	1-10th the indicated exposure.
Snow or Glacier Scenes, white or black and white prints or objects, sea views with shipping	S25 or ¼ " " "
Light coloured objects, open landscape (no foreground), lake or water scenes, half-tone photographs..	S50 or ½ " " "
Very deep *coloured* objects, as old oak, old paintings	S150 or 1½" " "

Another variation (quite apart from the subject) has to be considered when copying and enlarging, but this will be considered later on.

Selecting the Meter.—It will be seen that either an actinometer, or an exposure meter utilizing one, is a necessity for following the system of exposure I have laid down. The most convenient plan is, of course, to use the latter, as the scales do the necessary calculation, but a simple actinometer used with the $D/P \times A = E$ calculation is quite efficient for ordinary work (not copying and enlarging).

But the majority will prefer an instrument with scales. This is not the place to propound the commercial advantages of the several patterns sold. The basis of a calculation must be the ordinary slide rule, and provision must be made for working with the four indispensable values of Plate, Light, Diaphragm, and Exposure. It is easy to work these out on *two* scales, but the mental effort expended in a calculation depends on the ***number of values*** which have to be marked down by the eye, and is not lessened by reducing the number of scales.

I have, therefore, preferred in planning a meter to provide a *separate scale* for each value.



In the Standard Exposure Meter, a separate pointer is provided for each of the three factors, and after each is marked down, the final one indicates the exposure.

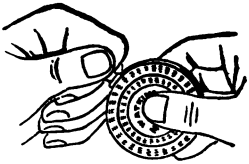
This form permits the two extra scales for enlarging and for subject to be provided, but they are passed over without notice when not wanted.

The complicated *appearance* of this form is against it, but in use it is quite as simple as any other, and it is certainly the most complete.

In this a long ribbon of sensitive paper is used, and can be used to the end without changing the paper. It is fitted with a pendulum for counting seconds.

The Bee Meter is of the more popular watch form, and is thoroughly simple and reliable, and not liable to go wrong. To use it, the glass is revolved (with the back) until the stop is against the plate speed. The exposure is then read against the light value as tested by the actinometer which is embodies in the instrument. To use it for copying or enlarging, tables have to be consulted.

In the Bee Meters the plate and stop value are set first, and as these values often remain unchanged for many exposures, the "calculation" then merely consists of reading the exposure against the actinometer value without resetting the scales. This advantage can only be gained by having *separate* scales for the three indispensable factors and the exposure. The tint opening has now only one tint, half across the circle, not two as in the illustration, as the presence of a second tint confuses the eye.



The scales of the Bee Meter are not set by pressing the fingers on the front of the glass only, but by gripping glass and back together as in this illustration.

The Bee Meter can be used with a chain pendulum if desired (a useful aid in counting seconds), and it is supplied in a more expensive form (hand finished and figures engraved) if desired, and also in combination with a stop-watch.

One great advantage of the Bee Meter is that its outer case will take several dials for special purposes. Thus, the Indoor Meter dial calculating with $\frac{1}{16}$ tint, the U. S. dial, Autochrome dial, quarter tint dial, and a series of separate dials each marked for one special camera with stops numbered 1, 2, 3 only.

Watkins' Meters were supplied to all three recent Polar Expeditions, Scott's, Mawson's, and Shackleton's.

Practical Exposure

I will presume that you have provided yourself with an actinometer or actinometer Exposure Meter (for if you wish me to help you in the matter of exposure no other procedure is possible) and are about to make a trial on an outdoor subject. The subject is one of average character, not of either of the special types enumerated under special subjects. Remember the rule is to:—*Test the light which falls upon the shadiest part of the subject in which full detail is required.* Therefore, if it is a street view, hold the actinometer close to the wall or house in the shade; if shady trees are in the foreground go partially under the shade of the trees. In any case, hold the instrument to *face the sky.* If it is not convenient to actually go to the shadow part, the shadow of the body may sometimes be substituted.

If the subject is evenly lighted and the shadows are so unimportant that they can be ignored, hold the instrument to face the full amount of the sky or sunshine as the case may be. Allow the pendulum to swing (if the meter is provided with one) and count seconds in time with one end of its swing. Move the sensitive paper so as to expose a sensitive surface, and at the same instant count aloud "nought," continuing one, two, etc., in time with the swing (one end of it only). Watch when the paper attains the same *darkness* as the darker painted tint alongside it, and note the number of seconds. Take care not to overshadow the actinometer with your head while watching the darkening paper. Do not think about a colour match, but merely in depth or darkness. The observation is much facilitated by holding meter at arm's length, and watching the darkening tint through half closed eyes. The number of seconds noted is the actinometer or A time.

The meter being set to the plate speed (as given on speed card) and to the value of diaphragm used, the A value is also set or consulted, and E scale will indicate in

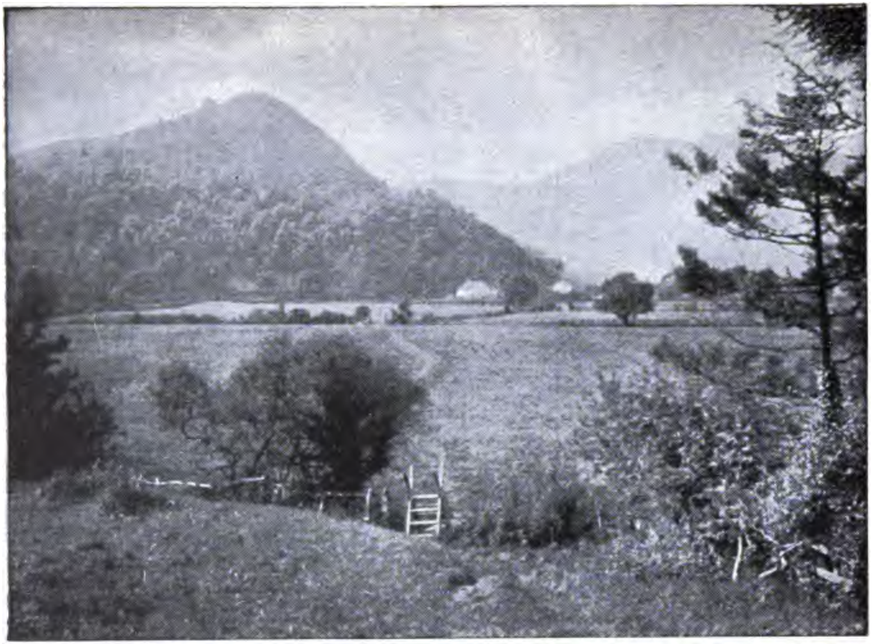


Fig. 12
Near Portinscale.
A pinhole photograph.
See page 60.

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seconds or fractions of a second the correct exposure to give.

Give this exposure, and remember that this first trial should be only regarded as a trial to verify the speed value of the plate. If when the plate is developed it proves over exposed, you must use a higher speed number in future, and *vice versa*. The speed number must be regarded as the *regulator* of the whole system of time exposure to be "set" to suit individual needs, but when correctly "set" it need not be altered while the same batch of plate is used. The next batch might possibly require another alteration.

If an alteration is required in the plate speed, not less than 50 per cent. should be tried. A change, for instance, from 90 to 100 is not enough; 130 should be tried if over-exposure has resulted with the first figure.

Objection is sometimes made to the use of a meter on the ground of the time occupied, and also that very often the light changes during the process. Both these objections are purely theoretical. The time occupied in the light test and calculation very seldom exceed half a minute, and the liability to a changing light applies equally to *all* methods of deciding the time of exposure.

Another theoretical objection to using an actinometer is that in photographing a view including deep shadow, such as hanging woods or a cliff, a river or other obstacle sometimes intervenes, and it is impossible to test the actual shadow light. The user of an actinometer, however, always improvises a similar shadow with his own body or shading with his hat.

I have found it most convenient when photographing groups, figure studies, or animals, to test the light and estimate the exposure *before* the final posing or selection of point of view. This obviates keeping your subjects waiting and watching—short as the necessary time is.

I have already given the variation to be made for special subjects—chiefly those which are altogether lighter than the average. But these variations need not be made so often as might be supposed. The compilers of tables, for instance, are very fond of speaking of the shorter exposure required for panoramic or distant landscape. It is true that such is often photographed, but in nine cases out of ten a foreground is also included, and this at once brings it into the usual average subject, for which the normal calculated exposure is right.

The user of an exposure meter is not bound to be a slave to its teachings, and very often a couple of tests will give all the information wanted for the day's work—perhaps a good round dozen of plates. Its use, too, becomes perfectly simple, almost instinctive.

Distance of Subject.—It may be taken as a general rule that, except when photographing near objects (less than 24 times the focus of the lens distance), or, on the other hand, extreme distance in landscape, no variation need be made for differences in distance.

When a very near object is photographed, the camera has to be racked out, and the exposure increases in proportion to the square of the increased focus of the lens. When the subject is more than 24 times the focus of the lens distance (18 feet for a 9 inch lens) this variation is too minute to be taken into account, and if the air were perfectly clear—as it is sometimes among the Swiss peaks—all objects beyond that distance would require the same exposure. In England, however, the slight fog or mist almost always present in the air, adds reflected light to the image of objects more than one or two hundred yards distant, and thus decreases the exposure (it is impossible to express this by rule, as it depends entirely upon the amount of mist in the air); this shorter exposure cannot often be taken advantage of, as pointed out previously.

Shading in Exposure.—The correct exposure for clouds is very much less than that for the landscape part of a picture. Where suitable clouds are present, and the exposure is made by hand, it is a great advantage to hold a piece of brown or opaque paper in front of the lens for three-quarters of the time of exposure. The paper must be held in such a position that (looking at the screen) it obscures the sky portion only. It is a great convenience if some form of clip be provided to hold the paper in position. A hoop of brass or tin fitting inside the lens hood, and provided with a saw cut through half its diameter, is a convenient arrangement. The edge of the paper can be roughly torn to suit the sky line. When one part of a picture is very brilliantly illuminated, and another part is in deep shadow, a similar procedure will be useful. The cloud effect on Fig. 11 (page 32) was secured in this way.

I have found it very important in outdoor photography to prevent more skylight falling on the lens than that included in the picture. An excess of light falling on the lens tends to fog. Above all it is necessary to remember that no direct sun rays must fall on the lens. It is often advisable to point the lens in the direction of the sun, in which case a temporary shade must be provided.

Interior Photography.—Here the actinometer is an invaluable guide, but it is obviously impracticable to have to occupy a long time in testing the light, and then to commence the exposure.

My plan (original with me) of exposing the actinometer simultaneously with the camera exposure, and using such a diaphragm that the two exposures shall be equal, is the one to use. It does away with all calculation after having once found the diaphragm to use with the particular plate speed.

But the full or standard tint of the actinometer is impracticable, as requiring an inconveniently small stop, and a lighter or "quarter" tint is provided on a separate dial if wanted. The sensitive paper darkens to the depth of this "quarter tint" in one-fourth the time required for the standard tint. Even a lighter tint (or a shorter darkening time) is in most cases still more convenient, and I have found that the first visible colouration of the paper is equal to a "sixteenth tint."

In the table below, the diaphragms to be used with different plate speeds are given, so as to make the time of exposure identical with the time required to darken to the "whole," "quarter." and "sixteenth" tints.

P.	Whole tint.	Qtr. tint.	1/16 tint.
11	F/28	F/14	F/7
16	F/32	F/16	F/8
22	F/40	F/20	F/10
32	F/45	F/22	F/11
45	F/56	F/28	F/14
65	F/64	F/32	F/16
90	F/80	F/40	F/20
130	F/90	F/45	F/22
180	F/112	F/56	F/28
250	F/128	F/64	F/32
350	F/160	F/80	F/40
500	.....	F/90	F/45

For interior photography, it is most important that the actinometer be held or placed in that part of the building the lighting of which is a fair average of the whole of the subject, neither in the *very deepest* shadow or, on the other hand, close to the window. If a "bit" of detail is being done the actinometer must be held in the position of the subject. In *every* case it must be held or laid down to face the window or source of light. Example:—A plate of speed 130 is used. Place a ¼ tint dial in the meter. Set the lens to F/45, place the actinometer in position as explained above, uncover a fresh surface of the paper, and at the same time take off the cap of the lens; when the paper has darkened to the quarter tint put the cap on the lens, and the exposure is finished. But you may prefer to use a larger stop, and take up less time. Set the lens to F/22, proceed as above, but as soon as the paper *begins* to darken put on the cap. The commencement of darkening (a faint grey tint) can be seen by moving the paper a trifle back and forward again. This is the sixteenth tint.

Keep in mind the golden rule to test the light which falls upon the subject. In practice it is easy to place the actinometer out of sight from the camera. An indoor dial fitted with the 1/16 tint, and calculating right with it, can be had, but but it must be kept in mind that the stained sixteenth tint provided in this aims to be the color of the *undarkened* paper, and not to match the first darkening.

I advise to make a trial sixteenth tint as follows, and keep it in the "mind's eye." Select some position in a dull light so that by trial with the meter the paper darkens to standard tint in either 16, 32, 48, or 64 seconds. Then carefully expose a fresh surface of paper for one-sixteenth the time, and observe the contrast between it and the undarkened paper. The Indoor Meter, fitted with $\frac{1}{16}$ tint, tests indoor light quickly and calculates the exposure with any stop direct from the $\frac{1}{16}$ actinometer time.

Portraits.—Whether you take these in or out of doors, hold the actinometer in the position of the subject when testing the light. If indoors, test the light, use the largest diaphragm to give the "depth of focus" you require, and estimate the exposure in the usual way, not following the method given for interiors. The ¼ tint is now fitted on a special dial calculating direct from it. This enables the light in studios to be tested in one-quarter the time of the usual full tint, and this fitted, the meter is a most convenient Studio Meter.

A portrait can be treated as an ordinary subject without allowance from the calculated exposure.

Copying. —When photographing very near objects (as in copying pictures or prints) another disturbing influence comes into play and tends to increase the required exposure.

The camera has to be racked out longer than the usual focus of the lens, and the value of the diaphragm becomes incorrect. But instead of having to work out afresh the value of the diaphragm, it is much more convenient to regard the lengthening of the camera as a separate influence which I have named the F factor, and to multiply the calculated exposure in accordance with the table below.

To use this table, cut a short stick the exact length of the focus of the lens, and use it to measure from the lens to the object. The number of stick lengths is the "times focus" in the table.

F TABLE FOR COPYING.

	Thin Neg.	Medium Neg.	Dense Neg.
	Black and White	Photographs	Coloured Pictures or Objects
15 times focus from lens	¼	½	1
10 " " " "	¼	⅝	1¼
5½ " " " "	⅜	¾	1½
3½ " " " "	½	1	2
2¾ " " " "	⅝	1¼	2½
2½ " " " "	¾	1½	3
2 " " " " copying equal size.	1	2	4

Example:—In copying with an 8 inch lens there is a distance of 20 inches, or 2½ stick lengths, between lens and subject, and a photograph is being copied. Hold the actinometer in the position of the copy and facing the light, calculate the exposure as usual and multiply by 1½ as given in the table above. The method and table is also applicable to lantern slide making, the three columns applying to thin, medium, and dense negatives. The speed of lantern slide plates for the calculation is given on the Watkins Speed Card.

The table really includes two distinct factors—S the subject and F the enlarging factor—and these two influences are provided for and *separately* valued on the Standard Meter, in which the exposure is calculated at once without reference to the above table.

Daylight Enlarging.—Here, again, the three invariable influences of speed of paper, size of diaphragm, and light come into force and are subject to variation. But (as in copying) there are also two others, the F factor to allow for the lengthened focus of the lens, and S the value of the subject (in this case the general density of the negative), five factors in all.

Now, in the estimation of each influence or factor there is that variation between different persons which scientific writers call the "personal equation," and when this comes to be multiplied by five it sometimes amounts to a serious variation between the calculated results of two persons using the same plan of exposure. In commencing, therefore, to calculate enlarging exposures, a trial is necessary to settle this "personal equation," and the result is expressed by a change in the speed number of the paper. In other words, the speed number of the paper given on a speed card must only be regarded as a suggestion for the first trial, and has usually to be modified in accordance with the trial. (In a minor degree this also applies to *all* systematic calculation of exposures.) It will probably be argued, "What is the use of calculating exposures at all if it comes back to making a test by the old method of trial and error?" The reply is that this preliminary trial serves as long as the same paper is used, and that future changes of light, degree of enlargement, etc., can be allowed for with perfect accuracy by the system.

The old rule to "test the light which falls upon the subject" must be followed in daylight enlarging, and the actinometer held in the position of the negative to make the test. If the lighting is from a reflector the actinometer must be so held that reflected light only falls upon it.

If the scales of Bee Meter are used to calculate the exposture, setting plate, diaphragm, and light to their respective values, the indicated exposure must be multiplied by the figures given in the enlarging table:—

ENLARGING TABLE.

Times focus from lens	Enlarging diameters	Thin Neg.	Medium Neg.	Dense Neg.
2	equal size	1	2	4
2½	1½	1½	3	6
3	2	2¼	4½	9
3½	2½	3	6	12
4	3	4	8	16
5	4	6¼	12½	25
6	5	9	18	36

The first two columns give the enlargement factor in two different ways, only one being required. To find the "times focus from lens" a stick should be cut to the length of the ordinary focus of the lens, and the number of stick lengths from lens to paper measured.

The diameters are reckoned by measuring the longer sides of the negative image and enlarged image.

Thus:—From ¼-plate size to whole-plate size would be 2 diameters.

(In the above table the two influences of enlargement (F) and density of negative (S) are combined, but in the Standard Meter separate scales are provided for them, and the exposure is calculated straight away without using the tables. In this case the dense negative would be S100, the medium S50, and thin S25. For the standard Meter the enlarging figures are expressed—not in diameters of enlargement—but in terms of the focus of lens from lens to paper.)

To estimate the enlarging exposure with a Bee Meter. Test the light falling on the negative. Set the ordinary diaphragm value against the paper speed, and read exposure against light value as usual. This result must be multiplied by the figure in above table *opposite* the enlarging value employed, and *under* the type of negative used.

Example:—With an 8 inch lens, a dense negative of S

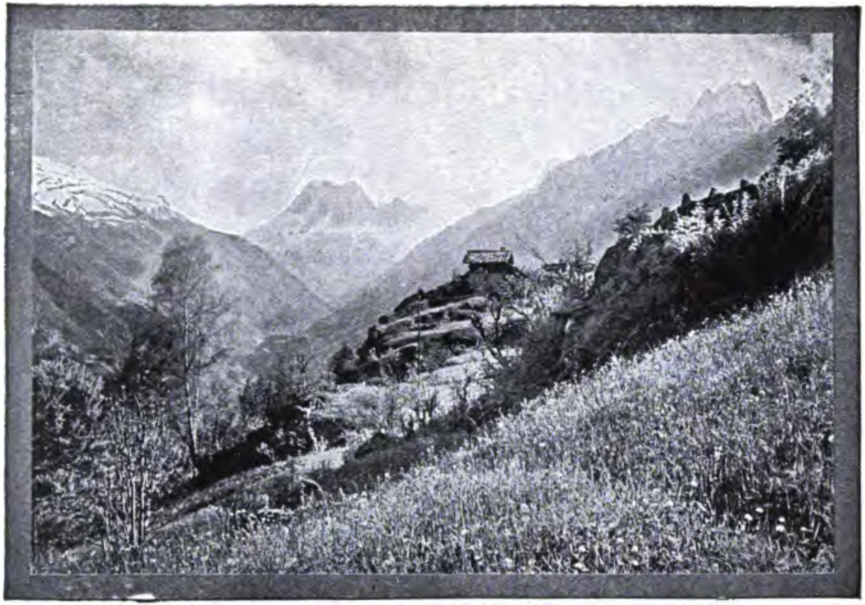

Fig. 13
Finshauts, Switzerland.
Clouds on same plate as negative, secured by colour plate and screen.
See page 64.

value 100 is being enlarged to double its length (2 diameters). The distance from lens to paper will be 24 inches (3 times focus) and the exposure will be 9 times the normal.

In measuring distances from a lens the surface of the lens may be taken as a measuring point in the case of a single lens, and the diaphragm in the case of a double lens.

Perhaps it is well to explain here the mathematical principle on which enlargement tables are based.

The F figure (distance of image to lens in terms of focus of lens) is always the same as the degree of enlargement plus 1. The exposure (as compared with that of the lens at its normal focus) is always the square of the F value.

Simplification of Enlarging, Copying and Lantern Slide Methods.—Experience has shown that the most convenient way of using the actinometer for daylight enlarging, etc., is to follow the method of calculating what diaphragm to use to make the actinometer test and enlarging exposure identical when a negative of standard or medium density is used, and then to vary the diaphragm to suit different classes of negatives. The calculation (with the aid of the enlarging table just given) is very simple:—Divide the number which represents the speed of the paper by the number in enlarging table under medium negative and opposite the degree of enlarging; the resulting number is the "D value" of the diaphragm to use, which value is given in the table on page 37. Example:—Speed of paper 24, enlarging 3 diameters, what diaphragm must be used with a standard (medium) negative? The number for this in enlarging table is 8, the diaphragm to use is therefore 24/8, or 3; look out 3 in the diaphragm table on page 37 and it will be found to be F/14, which is the diaphragm to use. If on first trial with a negative which you regard as your standard one it gives wrong exposure, you must *alter the diaphragm*, decreasing for over-exposure and increasing for under-exposure. After once getting this right further trouble will be saved. For negatives varying from your standard density vary the size of diaphragm used from the calculated standard one, opening out for dense negatives. The above method can also be used for copying, lantern slide or transparency making, consulting the copying instead of the enlarging table. (The same calculation can be done on the scales of the Bee Meter as follows:—The number from enlarging table being 8 (same example as above); look out this figure 8 on the plate scale of meter (figure with a dash against it). Set F/8 (as an indicating pointer) to this figure. Then against the plate speed number of the paper to be used (22 is nearest) will be found the diaphragm to use, namely F/14).

Calculating with a Fixed Focus Enlarger. — The above method cannot be used with most of the fixed focus enlarging or reducing boxes, as the diaphragms provided with them are not capable of alteration. The best way is to find (by calculation or by "trial and error") the correst exposure with a standard (medium) negative, observe the actinometer test of the light falling on the negative, and then note once for all the relation between the two.

For example, if the correct exposure is found to be 60 seconds, and the actinometer test 15 seconds, the exposure for a standard negative in future will be four times the actinometer test; for a thin negative, twice; and for a dense negative, up to eight times or more.

If it is desired to calculate the exposure out for the first time, it is necessary to take the F value of the stop. This is most conveniently done by pressing a piece of white paper on the opening with the finger and measuring the impression with points of a pair of compasses. This measurement stepped into a line the distance between lens and sensitive paper gives the F/- value of the diaphragm. Thus if diameter is ½-inch and distance 22 inches it is F/44. When the F/- value is taken in this way it makes allowance for the enlarging factor, and the enlarging table must not be used. A calculation made in the ordinary way on the Bee Meter with the above diaphragm value, the speed of paper, and the actinometer value of the light, will indicate the exposure for a negative the subject value of which is 100—that is a dense negative. For a standard or medium negative take half the exposure indicated on the ordinary scales of the meter.

Estimating Density of Negative.—In any plan of estimating enlarging—or lantern slide copying—exposures this difficulty is bound to turn up, and it has hitherto been somewhat troublesome. I should value what I call an average negative as S50, and some extremely thin ones (as cloud negatives) might be as low as S10; while very dense ones run as high as S150 or 200. The range is, therefore, a very wide one. The classification of negatives for enlarging is probably not the same as that for contact printing, for a foggy negative which, say, takes *twice* the time of another to *print* will probably take *four* times as long for enlarging on account of the defusive character of the fog. The color of the deposit has also a great influence.

Photographing Small Objects.—When small objects are photographed either by day or artificial light, the exposure can be calculated as described under *Copying,* if less than equal size; or as under *Enlarging,* if the photograph is larger than the original. The subject value may be taken as normal if the color of the subject is an average one, and if a transparent micro slide is being photographed its subject value is decided on the same principle as if it were a negative, the average being, probably, one-half, or S50.

Artificial Light.—Where any subject is illuminated by artificial light and photographed, the actinometer test will indicate the exposure as accurately as if in daylight. With illumination of the flashlight character, it is of course impracticable to use an actinometer.

But in enlarging by artificial light a condenser is generally used, and as this collects the light into a condensed path, it upsets the whole principle of calculation, and as far as I know it is no use attempting to us actinometer.

Trial and Error.—I have several times referred to the necessity of making a preliminary exposure to settle the speed value of the paper, and to avoid repeated error. I will suppose an exposure has been calculated with the speed number suggested on the Watkins Speed Card, and that the result is 30 seconds. It is desirable to make exposures both greater and smaller than this, and pick out the correct one. A suitable selection would be 15, 20, 30, 40, and 60 seconds. Instead of using a full sheet of bromide paper, place a long strip (full length of enlargement required) in position. Expose 15 seconds and cover up one-fifth of the negative; expose 5 seconds more, and cover up another section, then 10 seconds more and cover up a further portion, again 10 seconds and cover up, and then a final 20 seconds. The strip will be exposed in steps for the times first named, and the correct exposure can be selected and the P number modified in accordance.

This is called the method of trial and error, and is equally useful for camera exposures for settling the P number of a plate. In this case the shutter of the dark slide is pushed in between the exposures to give the required steps of exposure. Remember that the greater the exposure found correct the lower the correct P number (in exact proportion) and *vice versa.*

Copying Lantern Slide.—You may want to copy a lantern slide. To make a negative from it by contact, you would want to unmount it, but if you put the mounted slide with a sensitive plate in contact in the dark slide or back of whatever reducing camera you are accustomed to use, and expose through the lens against the sky, you will get a sharp result. About one-quarter the exposure you would give under similar circumstances when making a lantern slide from an average negative, will be about right.

Hand Camera Work.

Advice on the choice of a hand camera is usually waste of time, as the listener in nine cases out of ten accepts such advice if it coincides with his own fancy, but otherwise ignores it. The great convenience of daylight changing with rollable films, and the ease with which a new surface is brought forward after each exposure makes the Kodak type of camera a great favorite. This is slightly counterbalanced by the rollable films being a little less convenient than glass plates to develop, fix, dry, and store after printing. Flat films also offer many advantages over plates as regards weight when on tour, and they are more convenient than the rollable variety to manipulate, besides offering the advantage that it is easy to develop a single film.

Where films are used in dark slides, I should strongly advise the use of the special thin film slides and not film carriers in the usual slides.

I am bound, however, to say that unexpected defects as regards markings and thinness of films are more apt to occur with celluloid films, either flat or rollable, than with glass plates, and, personally, I prefer to put up with the extra weight of glass even on tour. As regards size I strongly advise against anything larger than ¼-plate.

There are five distinct types of cameras, each with its special advantages. The selection of type depends on which advantage the buyer lays most importance, it being impossible to combine *all* the special advantages in one type of camera.

Folding Pocket Camera (originated with Shew). Advantage:—Portability and ready for use with one pull out.

Box Form. Advantage:—Ready for use, and solid for holding against wall or post.

Partial Folding Type (Alpha, Challenge, Sanderson). Advantage:—Full range of focussing and adjustments for architecture.

Reflex Type. Advantage:—Full sized image in view up to moment of exposure.

Vest Pocket Type. Advantage:—Extreme portability.

An extremely important point should be faced as regards the kind of lens fitted to the camera. The single lenses used in most cheap cameras are only supposed to open to F/11, and the full aperture is often less than this, about F/16. Roughly speaking, successful snapshots with these cameras (on inland scenes) are only possible when the sun is shining on the subject, and then only in summer, late spring, or early autumn.

Cameras fitted with double or rectilinear lenses have a wider scope, as the lens opens to F/8 and snapshots can be taken in a slightly poorer light, such as winter sunshine or good summer light when the sun is not shining. In fact this difference is the aperture of the lens about doubles the opportunities of using the camera with success. A still further advantage is secured by using a modern anastigmat lens with a full opening of about F/6, which again doubles the opportunities of snapshotting even over the rectilinear lens, and gives four times the opportunities in comparison with the single lens.

The greatest defect in most hand cameras is the want of a slow shutter speed. Do not be put off with a glib explanation that the shutter is "adjustable for various speeds." Many shutters cannot be made slower than about 1-20th or 1-30th of a second, especially those which depend for their speed on the winding up of the tension spring of a blind roller. A shutter speed of ⅛th or even ¼ can often be used on figure subjects in a dull light, the camera being steadied against a fence, wall, or shop front, when a faster shutter speed would give hopeless under exposure.

The combination of large opening to lens and slow shutter speed enormously increases the range of a hand camera, and is vastly more important than convenient methods of changing the plate or film.

To do good work with the hand camera the use of the proper shutter speed, or if the shutter speed cannot be altered, the proper opening of lens in relation to the light and speed of plate, ought to be just as carefully attended to as in making time exposures. An actinometer is valuable in hand camera work as it indicates when the light is too poor to make a snap shot.

TABLE OF MAXIMUM METER TEST FOR SNAP SHOTS.

Plate Speeds.	250	180	130	90	65	45
F/5-6	32	24	16	12	8	6
F/7	24	16	12	8	6	4
F/8	16	12	8	6	4	3
F/10	12	8	6	4	3	2
F/11	8	6	4	3	2	—
F/14	6	4	3	2	—	—

Reading *opposite* the stop used and *below* the speed of plates at the intersection will be found the worst light (as tested by the actinometer) in which a snap shot will be successful. A medium shutter speed and an inland subject is presumed. On the sea, snap shots may be taken in much poorer light than indicated.

Example:—With F/8 (full opening of an RR lens) and plate 90 successful snap shots may be taken when the actinometer takes 6 seconds.or less to darken; if considerably more than 6 seconds it will only waste a plate or film to expose.

If you are wise you will provide a stand for your hand camera, and give time exposures with a small stop whenever there are not moving objects in the picture. I remember once a several days walking tour with a hand camera in dull weather when I came back with a number of time exposures but had never used the shutter at all.

It is astonishing how often a time or slow shutter exposure can be given without the use of a stand at all by holding the camera with its side or base or back firmly pressed against a convenient post, fence or wall. In street scenes for instance I have found it easy to point a Brownie in any direction by pressing the back end against one of the many angles formed by the construction of a shop front.

One of the advantages of the box form of camera is that it is the most suitable for this application. A hand camera can often be placed on an uneven surface such as a heap of stones, a top of a wall, packed level with bits of stone, weighted with a large stone and a time exposure given.

In short, the proportion of successes you may make with the hand camera will depend on how seldom you use it for snap shooting.

Selection of Plates.—Except for winter work when the most rapid plate possible must be used at all hazards, I should strongly advise that where a maker turns out a top brand of exceeding rapidity, that brand should be left severely alone. Most of the exceedingly rapid plates will not give sufficient contrast, as in developing them there comes a point when longer development ceases to increase contrast between the tones.

These remarks do not apply to several makers whose top brands, although of course "the fastest plate made," are simply of useful moderate rapidity (about 130 on my meter), and right for summer snap shot work. By the way, no one need be afraid of over exposure when snap-shooting inland. On the sea or coast the glare of light reflected from water or sand makes exposure very short, and the usual "full opening" may give over-exposure in good lights. If you occasionally wish to use your hand camera on a stand for interior work it will pay to buy all your plates ready backed, for unless this is done it is difficult to ensure having a backed plate ready when you want it.

Shutter Speeds.—To secure moving objects with a specified sharpness on the plate requires a shutter exposure, the *minimum* speed of which varies, not only with the rate of movement, but with the distance of object and the focus of the lens. The following table is, therefore, approximate only, and the object is supposed to be moving diagonally. If moving straight across the picture, double the speed is required. A quarter plate lens is presumed.

Loitering, 1 mile per hour, groups of persons or animals not actively moving	1/10
Strolling, 2 miles per hour, slow walking or animals feeding	1/20
Walking, 4 miles per hour, slow vehicles, or carts.	1/40
Driving, 8 miles per hour, boats	1/80
Trotting, 15 miles per hour, cycles, yachts, boat racing, foot racing	1/150

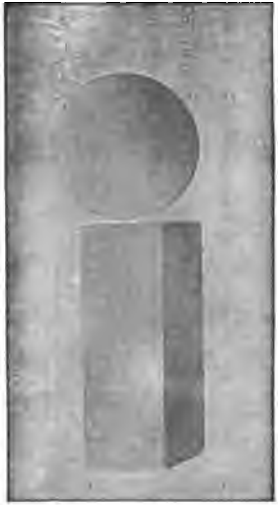

Fig. 19
Under development.

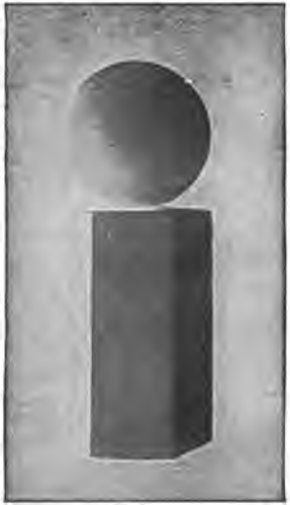

Fig. 20
Medium development.

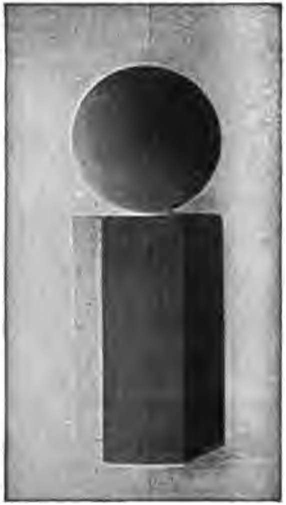

Fig. 21
Full development.

Illustrating increase of contrast with development of Negatives.
See page 73.

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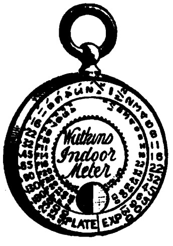
Galloping, 30 miles per hour, cricket, football and tennis, etc., sprint races, steamers, trains, motors, golf action and athletics generally, small birds flying	1/300
Express, 60 miles per hour, trains, motors, pigeons and sea birds flying	1/600

The nearer the object the greater the speed required.

Golden Rule.—*Use the slowest speed your subject permits.*

It is useful to remember that the Watkins speed nos. give, without calculation the highest allowable shutter speed for the plate with mid-day summer sun and F/8. Thus with plate 100 the shutter can be used up to 1/100th.

A good focal plane shutter gives exposures which are efficient at their marked values. That is: visual duration and light efficiency of focal plane exposures are identical. All lens shutters are inefficient in varying degrees. For example, a visual duration of 1/30th of a second will probably have a light efficiency of only 1/60th of a full second's exposure. But as this visual 1/30th is very apt to be marked 1/60th, the marked value will not be far wrong when used with an exposure meter.



The Focal Plane Meter (or Snap Shot Meter) is especially designed for hand camera work, as the diaphragms indicating opposite the shutter speeds, gives the information of what speed to use with a given stop, or what stop to use with a given speed, in the most convenient way. The speeds also are marked up to 1/4000. The outer case is different to that of the Bee Meter, and the dials are therefore not interchangeable.

DISTANCE IN FEET BEYOND WHICH ALL OBJECTS ARE IN FOCUS.

	f/4	f/5.6	f/8	f/11	f/16	f/22	f/32	f/45
4 inch focus	32	24	16	12	8	6	4	3
5 " "	50	37½	25	19	12½	8	6	4
6 " "	72	54	36	27	18	13½	9	7

Calculating Pinhole Exposures

Very efficient photographs of landscapes or still life objects can be taken without a lens, a small "pinhole" aperture taking its place in front of the camera. No focussing is required, as the image is approximately equally well defined with some variation of distance. The distance of course decides the "angle of view" or amount of subject included. The image is not quite sharply defined, but quite sufficiently so for artistic purposes, especially in larger sizes. See fig. 12, page 40.

The exposure is much longer than with the usual stops of lenses, and the high numerical value of the diaphragm has made it troublesome to calculate the exposure. A number of plans have been adopted to facilitate the calculation. My plan (published in early editions of this book and original) was to take a numbered sewing needle to make the hole, calculate its F/- value with a stated distance (or focus) but name it as a diaphragm sixty times its real area. This diaphragm (which is a size within those marked on a meter) is used to calculate with, and the calculated seconds exposure is given as minutes.

This disadvantage was that the diaphragm value was only correct at the working distance named, and as a pinhole will work at almost any distance, it is often convenient to vary it so as to get different angles of view.

Dr. D'Arcy Power (of U.S.A.), while adopting my plan of naming the aperture as if it were 60 times its true area, devised the plan of giving the value for 1 inch focus instead of an actual working distance. This made it possible to know the calculating diaphragm value for any working distance by multiplying the nominal number by that distance.

I have altered my original tables so as to embody the Power improvement, and as it is found that actual pinhole exposures require somewhere about 50% more exposure than calculated ones, I have made this allowance in the numbering. It is not however the fact, as stated in the

Photo Miniature booklet on the subject, that I have adopted Dr. Power's numbers.

I have named these new pinhole numbers W.P. (Watkins Power) numbers in order to avoid confusion with the usual needle numbers.

TABLE OF PINHOLE NUMBERS.

W.P. No.		Inch.	Nearest Needle No.	Most Suitable Distance,
3	=	.053	+ No. 1	40 inches
4	=	.040	+ No. 4	20 "
5	=	.032	No. 5	15 "
6	=	.027	+ No. 7	10 "
7	=	.023	No. 8	8 "
8	=	.020	+ No. 10	5 "
10	=	.016	+ No. 12	3½ "
12	=	.013	+ No. 13	2½ "

Rule.—Multiply the W.P. no. by the distance from pinhole to plate (focus), and use the result as an F value to calculate the exposure in the ordinary way. Then whatever the exposure indicated in *seconds* (or fraction of a second) give that same number (or fraction) of *minutes*. Thus W.P. 6 pinhole at 5 inches would be F/30; if used at 10 inches, F/60. A distance less than the length of the plate will give a wide angle picture; a distance twice the length of plate or more, a narrow angle picture.

There is no need to use a different size pinhole for each different distance; an average size such as W.P.6 will do for most distances, and for each of the distances in above table a smaller size hole than that stated will *not* give better definition.

The image can only be seen on focussing screen in very brilliant light; therefore, having levelled the stand and noted that the pinhole is opposite the centre of the plate, turn the camera round, and lifting the focussing screen apply the eye to the pinhole and see if the view wanted is framed in the end of the camera. Then turn camera round again for the pinhole to face the subject.

The pinhole apertures are conveniently made in thin

sheet brass (stencil brass), by driving the needle through with a series of light taps, the burr is cleaned off with a fine file, the needle passed through again and the hole blacked.

Another way is to break the needle through the middle, hold the broken end upright on an oil stone, and grind it perfectly smooth. With this, punch the hole through several thicknesses of tin foil (or capsule foil) placed on the end grain of a piece of hard wood.

A cheap and convenient pinhole "lens," mounted so that it will fit any lens flange light-tight, is sold with a revolvable disc carrying 4 pinholes (W.P. 6 to 12), and one focussing hole which although giving no definition permits the picture to be composed on the screen.

To make a Pinhole Camera.—Any box in which a plate can be secured at one end, and which can be made light-tight after inserting the plate, will do for the camera. The pinhole is of course opposite the centre of the plate and is made as described, unless it is purchased in the form described, in which case a 1¼ hole is cut. A flap or cap must be devised to cover the pinhole.

A 100-cigar box, flor-fina size, is right for a quarter plate. Strips of wood can be fastened at five inches from one end to secure the plate at that distance. If there is any difficulty in making the box light tight, it can be wrapped up in two thicknesses of black cloth. The box can be placed on some firm support to take the photograph and weighted down with a stone.

If your purse is shallow, and your ambition soars to large landscape work, it can be gratified with the aid of a home-made box for 12 × 10 negative paper. Paper in large sizes is much cheaper than plates, and is now issued by several makers.

Ortho Plates and Colour Screens.—When an object in different shades of black, grey, and white is photographed, approximately correct exposure and exactly correct development will give an accurate rendering of all these shades in the print.

But this is not the case when (as is almost invariable) the subject photographed contains different colors. Photograph, for instance (on an ordinary plate), a dark blue cap, with a bright yellow band. The print will show the blue part quite light in tone, and the yellow will "come out" an almost black band. A color which may be very luminous to the eye (red, green, yellow) may have very little action on the plate. We have become so used to seeing trees and grass much darker in a photograph than they are in nature that we scarcely notice the defect. It is a very grave one, nevertheless.

Fortunately, it is possible to sensitize plates for these colors. It is done by treatment with certain dyes, chiefly of the Erythrosine and Eosine group. Such plates are sold under the names—Isochromatic, Orthochromatic, Chromatic, Spectrum, and Rainbow. In using these plates for landscape work a slight improvement will be noticed in rendering the greens. But the plates are still not sensitive enough to red and green (and, therefore, to yellow, which is a mixture of red and green) to give them their full due in the print. But with the aid of a color screen (in front or behind the lens) colors can be correctly photographed.

A screen is of transparent glass or film, of such a color that it cuts off a large proportion of the blue and blue violet rays, but passes all the red and green. It, therefore, lessens those colors which are unduly active in chemical effect, and allows the others time to have sufficient action on the plate. A screen always increases the time of exposure. The deeper in color the more it increases the time. This increase can be roughly estimated (for ortho plates, not for ordinary ones) by making an actinometer test without the screen, and then another with it covering the meter. This will show whether it is three times, six times, or even up to 50 times.

I have found that in medium speed plates the colour sensitive brands are very satisfactory. They seem to give density more readily than the corresponding "ordinary" brand of the same make; and in some cases the "orthochronatizing" has increased the speed. In high speeds there is a little doubt about such plates keeping, but in medium and slow speeds I have found no disadvantage in using them entirely, and banishing "ordinary" plates from the dark slides.

Ortho plates—especially with a screen—tend to the rendering of clouds on the same negative as a landscape. As a rule only a very pale screen should be used, for with too deep a one it is possible to render green trees unnaturally light, and blue sky too dark. A screen tends to hold back the white parts of a subject, while more justice is done to those parts of red or green hue. See fig. 13, page 48.

Where blue haze is present in the distance and the haze effect is wanted for artistic reasons, a screen should *not* be used.

All color sensitive plates require extra care in exposing to dark room light, from which they should be screened as much as possible; covering up the dish except when absolutely necessary to uncover. Panchromatic and Spectrum plates are best handled in darkness.

Artistic Selection of Subject.—Because in this handbook I deal with the *tools* of photography, let it not be supposed that I consider technical excellence the highest aim. When *not* to photograph is the lesson which takes longest to learn. Let me give a few hints on some elementary matters of taste in selection.

Never expose with the sun directly behind the camera; the result is flat and unprofitable. Side lighting gives light, shade, and relief.

It is the foreground which in three cases out of four makes the picture.

Don't be afraid to try lighting with run in front, but keep it out of the lens.

In taking out-door figure subjects, the golden rule is that they must not show by attitude or looks that they are aware of the presence of the camera. It is not difficult to avoid this fault if you explain beforehand that you do not want to represent them "having their likeness took," but naturally at work or rest. Subjects should not show a divided interest, such as a glimpse down two paths; there must be unity.

Nothing towards the sides of the composition should lead the eye out of the picture; this is the great difficulty in river scenes, where a white patch of water leads off right or left.

A landscape in nature never has a bald white sky; therefore, if this occurs in a print you must print in one from a separate cloud negative.

In making cloud negatives, soft, quiet cloud bits are the most useful, not the most striking "sun behind cloud" or "feather bolster" style of thing.

Figures often greatly improve a landscape, but they *must* be "native to the scene."

Do not make the mistake of dividing the interest equally between figure and landscape. Either let it be a figure subject with appropriate but subordinate background or surroundings, or a landscape (or building, as the case may be) with the figure or figures of minor size and interest.

For interior work aim at *one* broad effect or lighting; two or three disconnected light effects spoil the picture.

Do not feel constrained to take in the *whole* of either the exterior or interior of a building; small bits, details of door, window, capitals, are often far better.

Portrait Work Indoors.—A sheet on a clothes horse is almost a necessity for lighting up the shadow side of the face.

A scene which promises well to the eye is often flat and disappointing when seen on the focussing screen. There is a way of judging this without setting up the camera. Three parts close the eyes, and glance at the scene through the narrow slits. The lights and shades assume a different appearance, which is more like what they come out when photographed.

Night Scenes.—Out-of-door night scenes with artificial lights and reflections showing, are very effective, but the foreground should either be wet street or water or snow. The secret is to make a short exposure, (less than quarter full exposure) before the daylight has quite gone, then cap the lens, wait until it is quite dark, and expose for the artificial light and reflections. A backed plate must be used, and only one plate can be done in the evening.

The time to make the first exposure is half-an-hour after sunset (consult an almanac), stop down to a stop a size smaller than that given in the table for the quarter tint (see under interiors), and expose for just the time the actinometer takes to *begin* to darken, that is, the 1/16th tint. The exposure for artificial light cannot be timed by actinometer; five minutes with F/32 will be about right for a quick plate.

The above is the method introduced by Mr. Paul Martin, but most workers now omit the twilight exposure and give from 2 to 5 minutes exposure with F/8 and a backed plate.

Kinematograph Exposure.—In "moving picture" work, the handle is usually revolved at a uniform speed (120 to the minute), and as the aperture of the revolving sector shutter usually remains unaltered (although the best Kine cameras have an adjustment for altering this), the convenient way of attaining correct exposure is to test the light with a meter and *vary the aperture of the lens* in accordance with the test. It has been found best to devise a special meter for this, in which the diaphragm values read against the shutter speeds. The use of a meter is most important in such work in order to get different parts of a long film (exposed perhaps in different lights) to approximately the same density for printing. As in the Focal Plane (Snap Shot) Meter, the standard of exposure adopted is half that of the Bee Meter. Different Cameras vary in the apertures of the sectors, and the diagram gives the shutter speeds, counting the opening from O to the dotted line. It will be seen that an opening of one-half the circle is 1/32 second. This is on the basis of the sector revolving 16 times in a second, the revolution of the handle being two to the second. A chain pendulum is useful to practice the half-second timing, but it must not be swung at the same time as revolving the

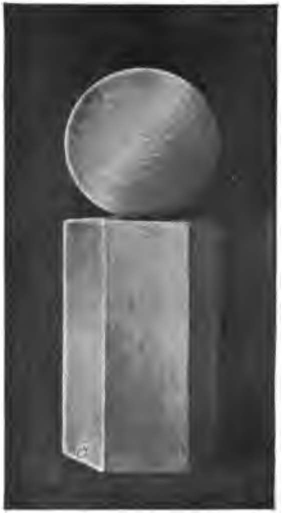


Fig. 22

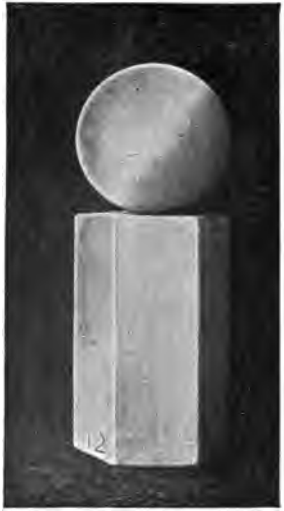


Fig. 23

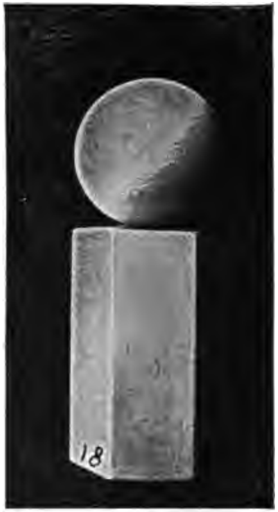


Fig 24

Prints from negatives developed 4, 6 and 9 minutes.
Showing increase of contrast. See page 74.

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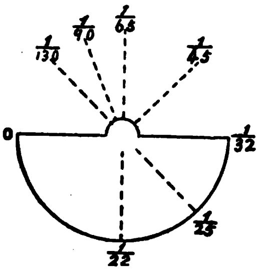
handle, as it tends to a jerky motion, whereas an absolutely even speed is essential.



Turning the camera handle too slowly causes the movement when shown on the screen to be *too rapid,* and if the handle is turned quickly, the exhibited picture will have a *slow* movement.

Colour Plate Exposure.—It was found very early with Autochromes that calculating with an actinometer and the usual scales did not give relatively correct results in summer and winter, in good and poor lights, with large and small stops, and therefore different users adopted different plate speeds under these variations. Most people have jumped to the conclusion that this is due to a deficiency in the actinometer paper in its color sensitiveness. But as a matter of fact, the steadfast paper (without claiming that the last word has been said on this point) is orthochromatic in character, as will be found by testing the light with and without a known color fitter over it. Moreover, the explanation obviously does not meet the difference between a large and small stop.

I traced the difficulty to a failure (in the case of all heavily-screened color plates, and even with Panchromatic plates used with a fitter) to a failure in the usual law that intensity of light and time of exposure are inversely proportionate. I estimate that when the light decreases 64 times (whether due to stop, indoor influences, or time of year, or day) the exposure requires an increase of 128 times, and so on geometrically. Accordingly, a special

Color Plate dial is supplied for the Bee Meter which makes this allowance in the calculation.

Autochrome plates, not having a thick film, have a small latitude in exposure; where there is a wide contrast between deep shadow and sunlight, it is therefore not safe to estimate the exposure by the deep shadow test, as the other part will be over-exposed, which tends to a pink hue. Therefore take either the sunlight test or the average between the sun and shadow test as the basis of the calculation. It is not possible with color plates to use for interiors the plan of selecting a stop to make the camera and actinometer exposures equal. But if the stop is small enough (F/8 for autochromes) the actinometer can be exposing at the same time as the camera plate, and there will be time to make the calculation when the paper has darkened.

To take color photographs of stained-glass windows, the theoretically correct way to use a meter is to treat the window as a transparency, and test the outside light falling upon it. I cannot give my own experience in this, but Mr. W. A. Slater has reported that he has secured splendid results by testing the light outside as it falls upon the window. If it takes X seconds, expose for X minutes on the window (inside), using F/11 for Autochromes. Paget Color Plates by the same method would require F/20.

Telephoto Exposure.—The increase of exposure over the ordinary lens is due to the magnification caused by the negative lens. This magnification must be known before the exposure can be calculated. The magnification can be found by measuring the camera extension from the centre of the negative lens to the focussing screen, dividing this distance by the focus of the negative lens and adding 1 to the result. The focus of the positive lens is in this instance not considered.

It saves trouble, having fixed a telephoto lens to a camera, to mark the baseboard for its different magnifications in the following way:—The focus of the negative lens is, say, 3 inches. Close the camera up until the focussing screen is in the same place as the centre of the negative lens. Mark the moving base against some index mark on the fixed base with the figure 1. Then from this, mark the moving base at 3 inch intervals (for a 3 inch lens), and counting from 1, number these marks as 2, 3, 4, etc. These numbers are the magnifications when the camera is racked out to indicate them. To calculate an exposure the diaphragm value (as marked on the positive lens) is multiplied by the magnification, and the new diaphragm value is used to calculate with by the meter. Example, magnification 4, positive lens used at F/8. Calculate this as F/32.

If more convenient you can calculate with the usual diaphragm value as marked, and multiply the exposure calculated with the meter *by the magnification squared.* In the above example you would (using this last method) calculate on the meter as F/8, but give 16 times the indicated exposure.

But keep in mind that a telephoto subject is usually a distant object, and if so half the indicated exposure is right, on account of the atmosphere between the lens and subject. Some form of deep lens hood or shade (to cut off sky not included in the picture) is a necessity in telephoto work to prevent fog by reflection on the camera or lens.

DEVELOPMENT

The Mental Picture.—It is best that you should get fixed in your mind a graphic idea of what goes on when a negative is developed. To do this go back to Fig. 3, page 16, with its four broad, simple tones forming four simple *steps* in gradation.

These steps do not exist in the plate until the developer is poured on, and during the process of development they are gradually built up.

You must think of the sensitive film as a substantial thickness (not a surface), carrying in its substance innumerable particles of the sensitive silver salt.

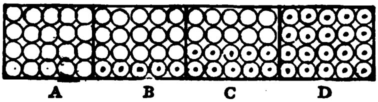


Fig. 14

Fig. 14 is an imaginary section (a slice cut through) of this substance, and the circles represent the sensitive particles each ready to be acted upon by light. Suppose that in the part marked A no light has fallen and none of the particles are effected, that on the part marked D a full amount of light has fallen, all the particles being affected, and are, therefore, marked by a dot. This part D might be the best lighted side of the pyramid, full white in the original and the positive, and, therefore, required to be full black in the negative. In the part C half the particles are affected (and half of them are therefore dotted) and in B one quarter are effected by the light. (These illustrations do not show *all* the facts, for in thickly-coated plates it is impossible to affect all the particles by light.)

A little consideration will show that if all the dotted particles are blackened by the developer, while all the undotted particles are left unblackened, the required *steps* will be secured. And this is just what does happen. The dotted particles (those acted upon by light) are reduced to the black metallic state by the developer, and, therefore, tend to make the film opaque in *proportion to their number*.

The undotted particles—those which there was not a sufficient amount of light to affect—are completely dissolved away by that process which follows development, and which is called fixing, and leaves the plate transparent, except for the blackened silver particles.

But this is the final result, and it is necessary to get a mental grasp of the stages which are gone through during development. Suppose that you have the plate graphically shown in the last figure, different parts of it having received different amounts of light, and different proportions of the sand-like particles altered by the light to the developable condition. To the eye there is no alteration in the cream-like plate. The developer is poured on the plate in a dish. Never mind for the moment what is consists of. It is enough to think of it as a solution in water of chemical salts which has the power of reducing—or blackening—those silver particles altered by light to the developable condition and dotted in our figure.

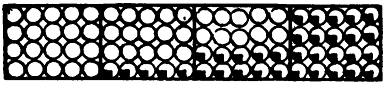


Fig 15

The developer takes a long time or a short time to do the full amount of work according to strength and temperature, but whatever the time, Fig. 15 gives a graphic idea of that stage of development when *one quarter of the work* is done. One quarter of the affected particles are blackened.

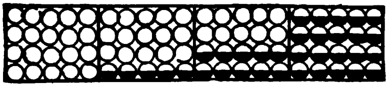


Fig. 16

In the next illustration is given a graphic idea of what has taken place when the development is half done. Half the affected particles are now blackened.

Fig. 17 shows the final stage when the developer has completely blackened *all* the silver particles affected by

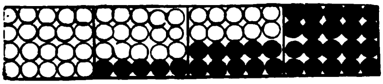


Fig. 17

light, and left untouched those not so affected. In most cases if the developer is allowed to act too long it will begin to darken even those particles which the light has not touched, and therefore tends to a general action throughout the plate. This is called *fog*.

I want you to notice two things in looking at the last three figures. First, the developer does the same *proportion* of work in each of the steps or tones at each stage (there is a slight exception to this in the early stages of some developers, but it is best to grasp the general rule), and if it appears to do more work in the deeper tones or steps, it is simply because there are more particles to attack.

Secondly, that if you were to hold up to the eye the darkened negatives, as represented by the three figures, and look through them, the first would show a fairly darkening and more contrast between the tones, and in the final plate the deepest tone or step would be quite opaque and show a very strong contrast to the faintest tone.

Therefore, to the eye (that is optically) the developer *appears* to build up the deeper tones faster than it does the faint tones, and tone D has increased in opacity (or printing quality) more rapidly than tone B.

This progressive action of the developer is so important that I must try to fix it in your mind by another graphic picture.

Imagine that the blackened articles in the last three figures are pressed down solid, and that the three steps in Fig. 18 represent them.

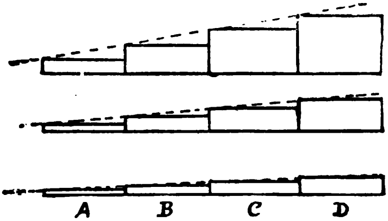


Fig. 18

Although each step is progressively built up in the same proportion, the steepness of the flight of steps increases as development proceeds, and in the final result there is much more contrast, or, as investigators call it, *steepness of gradation,* than in the early stage.

The dotted line indicates the degree of steepness, which, in the Hurter and Driffield plan of speed estimation, is called the development factor, or the gamma.

When a developer begins to fog it begins to fill up the lower steps.

Broadly speaking, no alteration of developer, after the tones have once appeared, gives the power to add to the fainter tones (or shallow steps) more than the deeper ones (the fogging power excepted), or, on the other hand, to add to the upper steps or tones without touching the lower ones. All non-fogging or clean-working developers do exactly that proportion of work on the different tones which has been decided by the exposure, the influence of bromide, described on page 110 excepted.

I had better explain the names which photographers apply to the different tones or steps of gradation. They are all named from their appearance in the object and in the finished print or positive. Thus the tone D is called the "high light," for although it is the blackest in the negative it represents white in the original. C and B are called "half tones," and the tone B, although the palest in the negative, is called "low" or "deep" or "shadow detail," because these terms apply to it in the positive.

Stages of Contrast.—I have tried to give an idea by imaginary diagrams of the condition of the negative at three stages of development. This is because we have to use a negative as a sort of transparent stencil plate from which to make a print, and the surface *appearance* is not so important as its quality of opacity or transparency.

But let me try to show (as well as can be done by *surface* appearance) the actual appearance of the negative of white wooden models at three stages of development, and, therefore, at three stages of contrast. Figs. 19, 20, and 21 (page 56) illustrate negatives developed for 4, 6, and 9 minutes.

Now you will remember that the negative is not a finished photograph in itself, but has to be put in a printing frame with a piece of sensitive paper behind it and exposed to day-light, the amount of contrast between the tones of the negative deciding the contrast between the tones in the print.

If there is sufficient contrast we should get a vigorous print. But if we use the thin negative, Fig. 19, (the one taken out at an early stage of development) we shall get a flat grey print with insufficient contrast between the shadow and high lights (Fig. 22). A print from Fig. 20 would be a little better, while one from Fig. 21 would give the full amount of contrast between the tones—see Fig. 23 (page 64).

It is usually possible to develop so far that there is *too much contrast* between the tones.

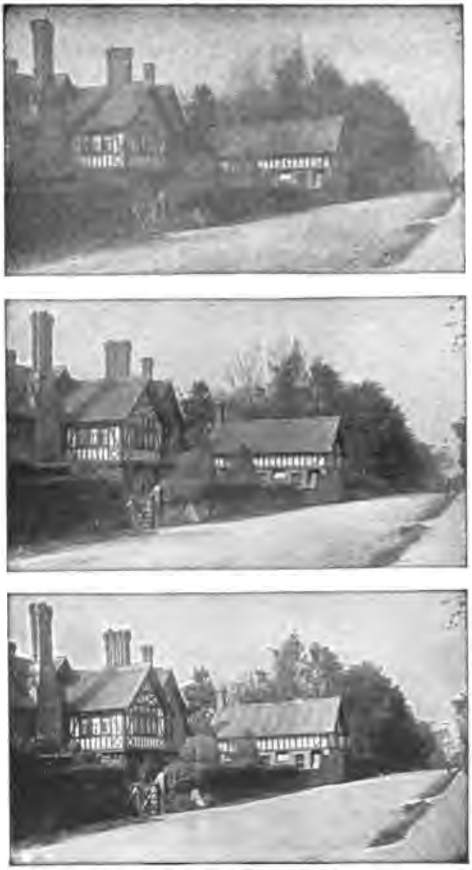
This fault of over development gives rise to what is known as the "soot and whitewash" kind of print as shown in Fig. 24.

A Question of Contrast.—Almost the whole power in development lies in regulating this contrast between the tones, just as the whole science of exposure aims simply at securing a *difference* in light action for the different tones. This control is most simply secured by regulating the time the developer is allowed to act. In the past history of development the same ends have been attained by more obscure and roundabout methods, but there is no need to investigate or adopt them.

The whole aim is to finally secure a proper contrast in the *positive* or print. I therefore give examples illustrating what kind of prints, negatives or different degrees of contrast will produce.

Fig. 25 (page 72) is from a negative taken out of the developer at an early stage, 4 minutes, and both negative and print have insufficient contrast. The second negative —Fig. 26—was left in longer, for 6 minutes, and the contrast is about correct. The final negative—Fig. 27—was left in for nine minutes, and the result is a hard, unnatural contrast, not representing the softly-lighted original, There is too much contrast between the tones.

As I shall probably use the term contrast again in regard



Figs. 25, 26, 27.
Prints from negatives of same exposure, developed 4, 6 and 9 minutes for soft, medium and hard contrast.
See page 74

Face Page 74

to development, it is necessary to explain that it does not refer to the extreme range of tones which happen to be represented in the subject. For example, two portraits might be taken, one of a lady in a black picture hat and a white dress. The other of a lady in a soft quaker-like costume, hat and dress alike. To correctly represent the tones, both negatives should be developed for the same time, and if this time is right, both would be said to be developed to a standard degree of contrast (or steepness of gradation), although it happens that in one subject higher and lower tones are represented than in the other. As a matter of fact a photographer would probably *not* aim at correctly representing the two subjects, but attempt to soften down the extremes in the one by a shorter time of development than the standard.

Limits of the Contrast Rule.—A very little consideration will show that the rule of increasing contrast only applies within limits. Contrast can only increase as long as the opacity (or density, as it is popularly termed) of the high light continues to increase, and when practically all light affected silver in that part of the film forming the high light is reduced, there can be no further increase of contrast.

Look at Fig. 18 (page 72) representing the steps. It is obvious that when the thickened step is as thick as it can be built, it is impossible to increase the steepness.

With many slow and moderate plates the top step can be made thicker, and the "steepness of gradation" much steeper than is likely to be required, and care must be taken not to develop too long. But with other plates—usually, but not always, fast ones—it seems difficult to get more than a very moderate amount of steepness, however long development is continued. These plates usually develop "quickly through to the back," and possess no latitude for variation in exposure.

Another important limit to the rule comes into force as soon as fog commences. You will have seen that fog is a darkening of the silver particles not affected by light. These are much the most plentiful in the lower tones or steps, and hardly exist in the high lights. Fog, therefore, tends to fill up the lower steps. As soon as it commences to appear increase of contrast is checked and soon ceases.

Fog.—Although a slight amount of fog is sometimes intentionally caused by the skilled photographer, it is usually desirable to avoid it. It is an error to suppose that fog brings out detail. True, it appears in proximity to the shadows, but it tends to "fill up the hollows," not to add to detail. It does not cease when once it commences in development, and if the plate is left in long enough will bring it to one even state of blackness. The use of a bromide (or other restrainer) in the developer keeps back fog during the early stages of development, but has no power to keep it back indefinitely if the plate is inclined to fog. It is usually considered that temperature in development has much to do with fog, and that it is more apt to appear at a fairly high temperature than a low one, but I have not experimented on the point.

Fog should be considered as apertaining to the plate rather than the developer. In some trials I made with six different developers, no bromide, and equal amounts of alkali, fog appeared at *exactly the same stage of contrast* in each case, although this was a much shorter time in some cases than in others.

The claim inevitably made for each new developer that it is more "free from fogging propensities" than others seems to be unfounded.

Where Developers Vary.—Let me explain that when I speak of different developers, I mean different developing agents (such as Pyro, Metol, etc.), and not merely different formulæ. Also that in speaking of *strength* of developer I refer to grains of developing agents to the ounce, not merely variations in the strength of the alkali used.

Perhaps the simplest way to understand how developers vary is to first see the points in which they are alike.

In a paper, "Some Developers Compared" ("Photographic Journal," April, 1900), I made a systematic comparison of six developers (Pyro, Metol, Ortol, Kachin, Hydroquinone, and Glycin), using equal strengths, equal alkali, and no bromide.

The results were summed up as follows:—

Effect on speed of plate...	Very slight or doubtful difference.
Searching out detail......	No difference.
Ultimate density power...	No difference discovered.
Fogging propensity	No difference.
Effect on different gradations	No difference.
Appearance of image.....	Wide difference.
Speed of working........	Wide difference.

In considering, therefore, the peculiarities and advantages of the different developers available to photographers, we need only consider (for the present) the last two variations, although some other difference is introduced when a bromide is included in the formulæ.

With the developers named, the times required to attain the standard steepness of gradation were as follows, the shorter the number, the greater the efficiency of the developer, with the alkali (sodium carbonate) used:—

Pyro	1¾	minutes.
Metol	1⅞	"
Ortol	2	"
Adurol	4	"
Hydroquinone	5¼	"
Kachin	6¼	"
Glycin	7	"

A mixture of Hydroquinone and Metol was more efficient than either, only requiring 1½ minutes.

All developers may be broadly divided into two classes.

The high factor class—represented by metol, rodinal, and weak pyro—in which all the tones appear very quickly in the course of development; but the plate has to be kept in a long time after the appearance, in order to gain a sufficient amount of contrast (or density). This class has the reputation of giving weak negatives, because photographers being deceived by the rapid appearance of the image take the plate out too soon.

It has sometimes been stated with regard to "quick appearance" developers, such as metol, that they have the peculiar property of bringing out the detail at the same time as the high lights. This is quite wrong, for the tones appear in exactly the same ratio of time as with low factor developers like hydroquinone.

In the low factor class—represented by hydroquinone, strong pyro, and adurol—the image appears very slowly, and by the time the lowest tones (shadow details) are out, the high lights have attained a fair amount of density, and sufficient contrast is secured in a comparatively short time after the appearance of the image. These give density rapidly, and have the reputation of giving harsh results, because photographers being deceived by the slow appearance of the image leave the plate too long in the developer.

Now the important point to remember is that as a general rule all these developers *give identical results if the plate is taken out at the same stage of development,* variations due to the use of bromide excepted.

It is, therefore, a matter of convenience which you select.

For general purposes it is most convenient to use one of a medium class, one in which the required contrast follows the appearance neither very rapidly or very slowly. It is a peculiarity of pyro (shared also by amidol) that used weak it belongs to the first class, and if used strong to the second class.

This division into two classes is not rigid, as there are developers which stand between the two, but it serves to explain the matter. I do not propose at this stage entering fully into the effect of other variations of the developer. It is sufficient to mention that variation of alkali only alters speed of working, that addition or variation of bromide has a more complex action, but gives very little practical control over results, and that dilution as a rule merely lengthens the time required to attain a certain result. More information on these points will follow the practical instruction I am now about to give.

How to Develop.—Select a developer which gives a suitable contrast in a suitable time—there being by preference no bromide in the formula—and do not depart from it or vary its proportions.

Stop development at that stage which gives the required contrast.

What Developer to Select.—One with a medium Watkins factor—not less than 5 or more than 15. You will know what this means when you get to the list of developers.

The formulæ given by makers are safe to use, being based on experience, but never be afraid of using so-and-so's developer with someone elses make of plates, there's no magic in particular mixtures.

Formulae.—I feel much tempted to write this book without giving a single formula, but perhaps I had better relent and give just a couple. One, Pyro-Soda, and the other Metol-Hydroquinone for those who object to the slight risk of stained fingers inevitable with pyro, and who also want an "all-round" developer which will do for bromide paper as well.

THERMO PYRO-SODA

No. 1

Pyro	160 grains	36.5	grammes	1 oz.
Metabisuplhite of Potash	80 "	18	"	½ "
Sulphite of Soda	2 ounces	200	"	5½ "
Water to make	10 "	1,000	c.c.s.	27½ "

No. 2

Carbonate of Soda (crystals)	4 ounces	400	grammes	11 oz.
Bromide of Potash	40 grains	10	"	¼ "
Water (warm) to make	10 ounces	1,000	c.c.s.	27½ "

One dram of each of Nos. 1 and 2 made up to one ounce with water contains two grains pyro.

In metric measure, 125 c.c. of each to 1,000 c.c. water.

The Watkins Factor for the above is 5, but if made up without bromide (perhaps desirable for factorial development) the factor is 12.

In winter the No. 2 Solution must be kept in a warm place or it will crystalise out.

THERMO METOL-QUINOL

No. 1

Hydroquinone	90 grains	21 grammes
Metol	30 "	7 "
Sulphite of Soda	2 ounces	200 "
Water to make	10 "	1,000 c.c.s.

Dissolve the Metol first, the Sulphite next, the Hydroquinone last.

No. 2

Carbonate of Soda	2¾ ounces	275 grammes
Water to make	10 "	1,000 c.c.s.

The Watkins Factor is 15.

Three-fourths dram of each Nos. 1 and 2 made up to 1 ounce with water makes a developer equal in energy to the Pyro-Soda as above. In metric measure 94 c.c. of each to 1,000 c.c. water.

If it is desired to use the Pyro-Soda developer with a factor of 6 (Sextuple method) use ¾ dram of each to the ounce instead of 1 dram (97 c.c.s. instead of 125).

The temperature co-efficient of both the above is approximately 1-9, but Pyro-Soda without Bromide is 1.5.

If it is desired to make up the Pyro-Soda developer without bromide (bromide in some cases slightly lessens the plate speed) it may be convenient to keep a 10% bromide solution, and add 5 minims to each ounce of developer if bromide is required afterwards.

Label.

10% Bromide

Potassium bromide 1 oz.
Water to make up 9 oz. 1 dram.

Every 10 minims contains 1 grain of bromide.

The Thermo Metol-Quinol with 2 to 5 minims of bromide solution added to the ounce will be found suitable for bromide paper or gaslight paper.

There is a decided advantage in using a combination developer like Metol-Hydroquinone. The metol ensures the rapid appearance of the tones, and the hydroquinone ensures density following quickly in all the tones, and the action is therefore quicker than if either had been used separately. This developer will keep well in a single solution of No. 1 and 2 mixed in equal parts if the bottle is kept corked.

It does not really much matter which developer you use when you follow either of the timing methods I shall give; for the timing makes allowance for those variations of alkali and strength which occur between different formulæ.

When to Stop Development.—You will now begin to see that development is something like a railway journey past roadside stations, and that as far as final result goes it does not much matter whether you travel by goods or express, *so long as you get out at the right station,* for you cannot get off the one line of rails unless fog comes on, and then you are on a different track at once.

If a given formula always worked at the same speed there would be no need to follow any other plan than to develop for a fixed time in order to get a fixed amount of contrast (to follow the simile I have given above, you would always alight at the same stage of your journey, if you did so at a given time from starting and the train never varied in speed). The fixed time would vary with different plates.

But it is inevitable in development that even an absolutely uniform formula will not always work at the same speed, for variations in temperature alter the speed enormously, and in practice slight variations in the chemicals used also alter the speed of working. I know of nothing so misleading in the way of developing instructions than for a writer to glibly advise that the developer be used at (say) a uniform temperature of 65°; for nothing short of bringing the dish, the plate, and the surrounding air to the stated temperature will secure uniformity. It is quite useless to warm or cool the developer alone to the required degree, for within half-a-minute after pouring on it will strike an average with the temperature of plate, dish, and air, and then gradually rise or sink to the same. If you have a perfect warming and cooling apparatus to your dark room you need only develop for a fixed time at a fixed temperature for a stated plate, but the time for different makes of plate or film varies enormously.

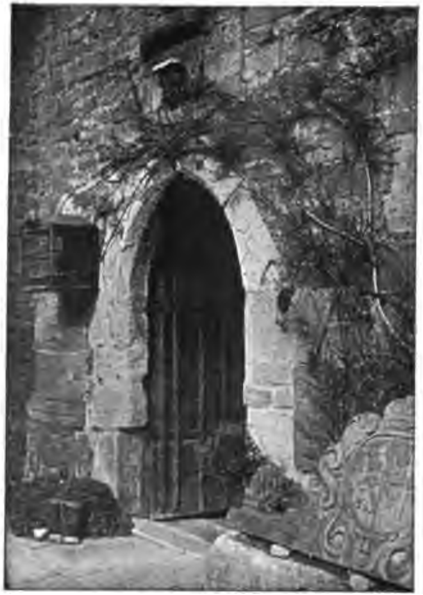
But as you are probably in the same condition as all photographers I know, and have no such advantage, I will proceed to indicate two methods which make allowance for these variations.

In the beginner's chapter I have described the dark room arrangements.

The Two Timing Methods.—The developer being fixed upon, and a standard contrast in the negative also decided, some method of making allowance for the very great differences caused, firstly by temperature, and secondly by make of plate, is required. It is possible for a slow developing plate at a low temperature to require fifteen times the development of a quick developing plate at a high temperature to get the same result, the same developer being used.

I advise that either one of two distinct methods be employed. The one, which has proved a great success in use, is FACTORIAL DEVELOPMENT, and the method makes allowance for make of plate, temperature, and (to a limited extent) accidental variations in the energy of the developer. It however requires a dark room light and an observation of the plate at the commencement.

The other, which is of more recent growth, being introduced (as regards a complete table of temperatures) by Mr. Ferguson, K.C., may be called THERMO DEVELOPMENT. It makes allowance for the temperature, but it makes no allowance for variation of different brands of plates, requires a first test to settle the time or dilution for a particular plate. But as it does not necessitate a dark room light, nor an observation of the plate, it will probably be largely used in future, especially as it is theoretically accurate. The new aids which I have devised to Thermo Development, by giving (with reservation as to inevitable variations of different batches) the development classification of different plates on the speed card, and the variations for temperature by times on a thermometer will, I think, extend its use.



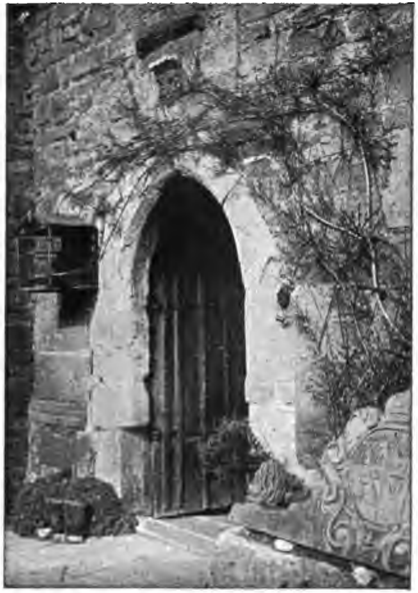


Fig. 28
Four seconds exposure.

Fig. 29
Half second exposure.

Illustrating latitude of plate with unaltered developer.
See page 104.

Face Page 82.

Thermo Development

The proportion between the time for developing at, say, 68°, and that at, say, 50°, is always alike for a particular developer, but varies with different developers. Thus with Metol the ratio between these temperatures is only about 1 to 1.25, while with Hydroquinone it is much more, namely, 1 to 2.8. These figures are called the temperature coefficients for the particular developers, a difference of 10° C (or 18° F) being the standard to take.

The temperature coefficient being known, and also the right development time for a particular plate at a particular temperature, it is easy to draw up a table of times for all temperatures for that particular plate.

The method of drawing up this table for any chosen developer is indicated a few pages on, and with such a table and a thermometer further instructions are not needed.

But the full WATKINS THERMO METHOD goes further than this. Recognizing that plates vary in DEVELOPMENT SPEED just as widely as they do in exposure speed, it attempts to give this approximately in the speed card, by classifying them all into eight groups, and indicating these groups by code letters from V V Q (for very very quick) to V S for very slow. It is then possible to do either one of two things with this classification (a) to give the *minutes* for each group necessary to attain a standard result with a stated developer at a standard temperature (60° F), using a moveable scale, such as the diagrams to be given a few pages on, to calculate variations for other temperatures; or (b) to settle on a standard time (say 6½ minutes) for the standard result at 60° F, and to indicate under the code letters the concentration (or dilution) of developer required to attain this with each group.

DEVELOPMENT. CODE FOR TIME.

(Method A.)

VVQ	VQ	Q	MQ	M	MS	S	VS
1¼	2¼	3	3¾	5	6½	8½	11½

The figures under the letters are the *average* time (in minutes) for the group in which the plate is placed, at 60° with the dilution of developer given in the next section under M S; but are also useful as indicating *relative* times with any developer.

Notice how greatly plates vary in the time of development required.

But as this requires a different temperature table for each group of plates, or a sliding scale, it is not so simple in use as the next method (b) which is now the standard WATKINS THERMO METHOD, as it can be used with a fixed scale of times with different temperatures, the variation for different groups of plates being made by variation of developer dilution.

Dilution of Developer.—To be decided as under according to the development speed of the plate as indicated by code letters on the Watkins Speed Card.

Note that these strengths of developer should be taken *as a suggestion for a first trial.* If from results, more contrast is required in the negative, adopt a step higher in amount of concentration of developer, if less contrast is required adopt a step lower towards VVQ end of code.

CODE FOR DILUTION.

(Method B.)

Drams each solution

	VVQ	VQ	Q	MQ	M	MS	S	VS
Thermo Pyro-Soda	1	1⅓	1¾	2¼	3	4	5	6¾
" Metol-Quinol ..	¾	1	1⅓	1¾	2¼	3	4	5

Make up above quantities to 3 oz. water for dish, or 10 oz. for tank development.

Minims solution

Certinal, Victol	VVQ	VQ	Q	MQ	M	MS	S	VS
Rodinal, Azol, Kodol.....	20	26	35	45	60	80	105	135

Make up above quantities to 3 oz. water for dish, or 9 oz. for tank development.

A total quantity of 3 ounces is selected, being right for two quarter plates or one half plate, and all the quantities can easily be halved or doubled for other uses.

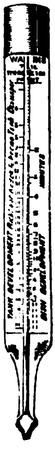
IN METRIC MEASURE.

	VVQ	VQ	Q	MQ	M	MS	S	VS	
Thermo Metol-Quinol	30	41	55	73	94	125	165	210	for dish
	9	12	16	22	28	38	50	65	for tank
Thermo Pyro-Soda	41	55	73	94	125	165	210	280	for dish
Thermo Pyro-Soda	12	16	22	28	88	50	65	84	for tank
Certinal, Victol	13	17	23	30	40	53	70	90	for dish
Rodinal, Azol, Kodol	4.3	5.75	7.75	10	13	18	24	30	for tank

The above figures are c.c.s. to be made up to 1,000 c.c.s. (1 litre).

The standard time for all the above is 6½ minutes for 60° F for dish development or 24 minutes for tank development, the variation for other temperatures being given by the Watkins Time Thermometer. All the above developers are approximately the same temp. coeff., namely 1·9.

Time Thermometer.—The time to develop is read directly from the height of the mercury without calculation or adjustment of any kind, the time for 60° being fixed at 6½ minutes.



The strength of developer is adjusted (once for all) to make the standard time right for the particular plate, and for the user's choice of contrast in negative.

The thermometer thus allows for temperature variations, and the dilution of developer for plate variations.

Either one of at least seven different developers (formulæ have already been given for two) can be used, and a table of dilutions is given above.

One side of the thermometer indicates for DISH development and the other side for TANK development with developer still further diluted. But of course the dish times are available for tank use if the stronger developer is used. The thermometer is available for films as well as plates.

To use the Thermometer.—Only a darkened room (no dark-room light) is required. Having selected and mixed the developer according to the plate used (see DILUTION OF DEVELOPER) at the natural temperature of the room (using water which has stood in the room some time to attain that temperature), dip the thermometer in the developer, and the time to develop will be read against the top of the mercury. The reading is on right hand side if for strength of developer as given for *dish* development (3 oz. dilution) or on left hand side if for *tank* development with 9 or 10 oz. dilution.

In dish development with the thermometer the plates are put in the dish in the dark, the developer poured on, the dish covered up and left for the indicated time, with one or two tiltings. The gas may be turned up while the cover is on.

The dilution must only be taken as a suggestion for a first trial, as with some makers, different batches of plates vary considerably in development speed.

The dilution indicated is for a contrast (gamma, or development factor H. & D.) of 1. Unfortunately quite a number of rapid plates do not attain this standard with any development, and for these a new standard of approximately the highest contrast they can attain has to be adopted.

Kodak Tank Development.—The left hand side of the thermometer indicates the correct time (about 20 minutes at 65°) for all the Kodak and Premo Film Tanks with their appropriate Kodak Tank Powders (not Kodak special powders).

Or, if preferred, the developers in the table can be used diluting as for S (for Kodak Film).

Using the thermometer for Kodak *Plate* Tank the various dilutions for different plates cannot conveniently be managed with the Kodak tank powders, and the developers in table should be used.

It should be noted that the Watkins thermometer and system provides accurately for the two important variations which have hitherto been imperfectly dealt with or altogether shirked in time tank instructions, namely, the large time variations for different *plates,* and for different *temperatures.*

Tank Development.—The thermo method is exactly suitable for timing development in any of the numerous tanks and developing machines now sold, and the development code given on the speed card can be used to decide the dilution. Develop at the natural temperature of the room—notwithstanding the tank makers' instructions to the contrary—as the thermo scale will make correct allowance. Take care that a large jug of water has been provided beforehand to attain the temperature of the room.

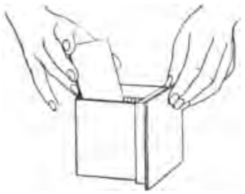
In all tank development it is most important that either the developer is moved over the surface of the plates (or films) or the films moved about in the developer two or three times during development, which otherwise would be uneven. How this can be done depends upon the construction of the tank. Either lifting the plates or films up out of the developer and replacing, or turning the whole tank upside down, will do the necessary slight agitation.

Watkins Time Tank.—This is especially designed for the use of the time thermometer, the spout serving not only to dip the thermometer, but for pouring the developer out and in again to prevent markings. It has an aperture for washing, and the plates being horizontal, a lessened number can be developed with a correspondingly smaller quantity of developer, which, however, should never be stinted.

It has only two parts, the rack being attached to the lid. It is now made of German silver in the Company's own works—a great improvement on the earlier issues.

Instructions.—Filling the rack is commenced from the bottom, the face of the plate being upwards, towards the lid.

In a completely darkened room take the lid and rack out



of the tank. Lay it on table as illustrated, the grooves being vertical and the bottom of rack to the right. Take the first plate in right hand, as in illustration, the film being outwards, and *pressing the lower back edge against the bottom of the rack,* hold it at a slight angle from the perpendicular, as shown in the illustration. If held at the right angle the corners will neatly slip into the first pair of grooves without trouble, and if then held upright will drop into place.

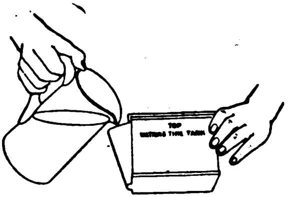
The top edge of the first plate (fully inserted) will now form a guide to press the lower back edge of the second plate against. This is held *at the same angle,* and will slip into the second pair of grooves. The other plates are inserted in the same way.

The rack is then inserted in the tank. When closed, the tank can be taken into a light room, in which all subsequent proceedings take place.

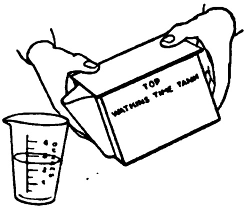
Note that the illustrations are taken from the position of the onlooker, the right hand being on the left of the picture.

Developing —Having decided upon the kind, strength, and quantity of developer to use (see thermometer instructions) get it ready mixed. If the quantity is too much for the measure, an ale glass or small jug can be used to hold it. Set the dark room clock (if one is used) to zero.

Place the tank on the table in front of you so that the word TOP reads right way up. Now tilt the tank sideways (towards the body) and pour the developer in as shown on the illustration. The sideways tilting is important, as the grooves come at the sides, and not at top, to baulk escape of air. Let the tank down flat on table;



start the dark room clock, or (if one is not used) note down the time; tilt the tank once or twice. Dip the time thermometer in the spout, and after leaving it there for a minute note the time required for development against the mercury. During development it is important that the developer be moved over the surface of the plates several times. This may be done (with a few plates) by tilting the tank, but the more efficient way is to pour all or part of the developer into the measure or jug, as illustrated, and then back again at once. It is more important to do this with Pyro than other developers.



When development time is completed pour off, and place the tank so that the top aperture (not shown) is under a tap. After a few minutes pour off the water and fill up with fixing solution, not acid. The plates after fixing may be washed in the tank under the tap.

Temperature Tables.—The Thermo methods hitherto described apply to a limited group of developers of one temperature coefficient (1·9). The reader may wish to draw up a table for his own pet developer, from his own trials, and the following information is for that end.

As a general rule the temperature coefficient of a developer does not seem to be altered by dilution, nor by different proportions of alkali, but it is much higher with bromide than without.

The following table is from tests made by the writer. In the case of pyro-soda they seem to agree fairly well with tests by other experimenters, but in some other cases —as hydroquinone—there are great variations:

TEMPERATURE COEFFICIENTS.

Pyro-Soda (without Bromide)	1·5
" " (with Bromide)	1·9
Kodak Powders and Kodol	1·9
Rodinal, Azol, Victol, Certinal	1·9
Metol-Quinol	1·9
Glycin (tabloid)	2·3
Rytol (tabloid)	2·2
Hydroquinone (tabloid)	2·25

Ascertaining Temperature Coefficient.—It has been found that an observation of the *time of appearance* makes correct allowance for changes of temperature, and this provides an easy way to make the test. Make any landscape exposure, including a sky, and cut the plate in half (or make two exposures). Take a large dish or pan of warm water, get the dish, measure, thermometer and the developer to its temperature by immersing in it. Float the dish on the water and (in dark room, of course) put one plate in the dish, leaving a few minutes to attain same temperature, pour on the developer, and accurately count seconds so as to observe the first appearance of the high light. Note this down and also the temperature of the water, turning up full light for the purpose and not troubling to continue development of the plate.

Now make a similar trial with the duplicate plate at a much *colder* temperature, using cold tap water in the outer dish, as before, and bringing all to the same temperature. If in winter the cold development may be at the natural temperature of the room. Note in the same way the time of appearance of this cold trial. Convenient temperatures for the trial would be 50° and 70° or 75°. The cold should not be below 40° or the warm above 80°.

In order to calculate the temperature coefficient from the diagrams on page 90 a paper scale of temperatures must be marked out, and this scale provides for the future a complete calculator for all temperature variations with the particular developer.

Lay the edge of a sheet of note paper along the logarithmic scale, and mark off the distance between the times (of appearance) of the two tests.

Apply these marks to the temperature scale at right angles to the central line, so that one mark is coincident with the line of warm temperature, and the other mark with the cold temperature, moving about (strictly at right angles) until this position is found.

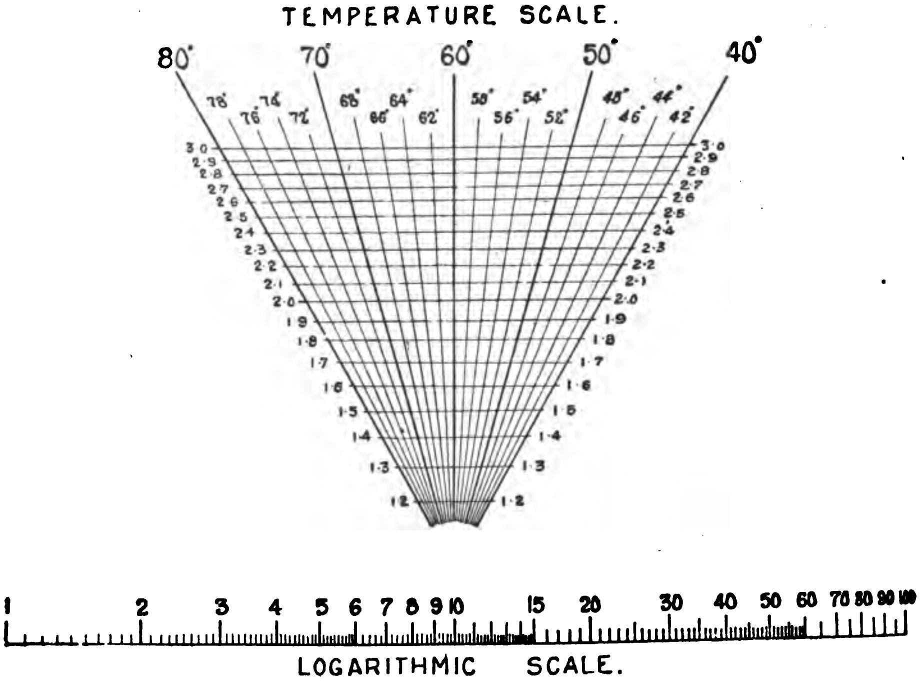
Then mark on the edge of the paper the position of each of the temperature lines, and also mark the temperatures against them. This paper forms a scale for future use. The point at which it intersects the central line is marked on the margin with the temperature coefficient, and this should be noted in the new scale. This new scale is in future used by placing against the logarithmic scale, as the fan-shaped scale is only used for plotting out in the first instance.

Example:—

Cold trial, temperature 52°, appear 46 seconds.
Warm trial " 70°, " 22 "

The temperature coefficient of the developer will be found to be 2·1.

Making a Time & Temperature Table.— Having ascertained the temperature coefficient of the particular developer used, you can draw up a complete table of times and temperatures for the plate you use with the aid of the diagram on p. 90. It is first necessary to ascertain by a trial the time required at a noted temperature to give a negative of the contrast you prefer. Suppose this time is 5 minutes, the temperature of the trial development 62°, and you have ascertained the temperature coefficient (either from actual time as in previous section, or from information received) to be 1.9. Place the edge of a piece of notepaper along the horizontal line marked 1.9 on the diagram, and mark off the position of all the temperatures, making longer strokes at the even 50°, 60°, &c. Label these divisions. Then apply this scale to the Logarithmic scale on the diagram, so that 62° is against 5 (minutes). From this setting write down your table, the correct times being all opposite the temperatures, thus:—60° = 5⅓ minutes, 58° = 5¾, 56° = 6¼, etc.


TEMPERATURE SCALE.
80°
70°
60°
50°
40°
78°
76°
74°
72°
68°
66°
64°
62°
58°
56°
54°
52°
48°
46°
44°
42°
3·0
2·9
2·8
2·7
2·6
2·5
2·4
2·3
2·2
2·1
2·0
1·9
1·8
1·7
1·6
1·5
1·4
1·3
1·2
1
2
3
4
5
6
7
8
9
10
15
20
30
40
50
60
70
80
90
100
LOGARITHMIC SCALE.

Fixing the Plate.—Make a fixing solution by dissolving 4 ozs. of hyposulphite of soda in 20 ozs. of warm water, and allow it to cool. Having poured some of this into its dish (which must be kept for that purpose alone) to a depth of nearly half-an-inch, place the plate in the solution face upwards. The creamy appearance of the plate will gradually disappear, as the "hypo" (the short term used for the fixing bath) dissolves all the silver particles not affected by light and development. When the plate is clear of milkiness, do not take out at once but leave in for as long a time again. As the hypo acts quicker in summer than in winter, and also acts slower when used several times, it is impossible to give a definite time for fixing, but no damage is done if the plate is left in four or five times too long. A fixing bath is generally used several times over, for a dozen plates or so, but a given amount of hypo is only capable of fixing a given number of plates, and it is a bad plan to work too near the limit. If the milkiness of the plate has not disappeared in ten minutes, the bath, probably, has been worked near its limit, and a fresh one is wanted. The slightest touch of hypo on sensitive papers or plates is apt to cause stains, and it is therefore important after touching the fixing bath (or even the bottle or dish containing it) to wash the fingers before the matter is forgotten. After fixing, the plate may be freely exposed to light.

The best fixing dish I have used is a small stoneware pig's trough of a section like half a drain pipe. It takes either half plates or quarter plates, face downwards.

Washing the Plate.—The hypo must be thoroughly washed out of the plate before it is dried. This is done by placing it in *running water* for an hour at least in an upright position or face downwards by preference. Of course the film must not touch the bottom of the vessel if face downwards, but it is sometimes possible to find a pie dish which has rounded corners capable of holding the plate in this position.

If no other plan is available than face upwards in an ordinary dish, the water must be changed half-a-dozen times even if under the drip of a tap.

I cannot too strongly express the opinion that if commercial washing appliances (either for plates or films) are purchased, they should be of some form of porcelain or ware. Japanned metal or zinc washers will wear out in one-tenth the time in the unfavorourable conditions of a dark room.

Drying the Plate.—Stand up on edge in a warm place on a strip of blotting paper, or a wooden folding rack is convenient. If a couple of nails be driven into a wall about the width of the plate apart, the plate will rest angle ways on them to dry. The film must be outwards.

Factorial Development

I discovered in 1893, as a result of a large amount of experimental work, that with any given developer the time of appearance of the image gave an accurate indication of the speed at which the developer was working; and that any variation of temperature or of amount of alkali (within limits) which lessened or increased the time required to attain a certain degree of contrast, also lessened or increased in the same ratio the time of appearance. This "time of appearance" is the exact time elapsing between the pouring on of the developer and the first appearance of any trace of the image.

With most developers the time of appearance also indicates the altered time of development required by changes in the strength of the developer, but this does not apply to pyro or amidol.

The timing plan which I introduced and now explain is to develop the plate for a certain multiple of the time of appearance, and a standard degree of contrast will always be secured, even with considerable changes as regards temperature or alkali. This multiple is called the multiplying factor. To avoid confusion between it and the Hurter and Driffield "development factor" (which is an entirely different thing) several authorities have elected to call it the "Watkins factor." It varies for different kinds of developer, but not for different strengths of developer (except with pyro or amidol). The plan was formerly named by me the Eikronometer method; and really amounts to making a test of the activity of the developer and regulating the time of its action accordingly. It is often used with the aid of a watch, but the minute hand of this not being easy to read in the dark room a special clock is a great luxury and convenience for the purpose; the minute divisions being large and plain, only 10 to the complete circle. The centre seconds hand also enable the time of appearance to be easily noted, and the stop lever adds to convenience in use. Its size is larger than the early pattern.

I will give instructions for using the factorial method either with aid of a watch, or with the dark room clock.

Practical Development with Watch.— Practice counting seconds in time with second hand of watch. Go in the dark room; mix your developer ready in the measure, a convenient quantity being 1½ oz. for a quarter plate and 3 oz. for a half plate. Do not at first attempt to use the minimum quantity of 1 oz. for a quarter plate or 2 oz. for a half plate. Place the exposed plate face upwards in the dish (be sure it is clean), take out your watch, note when the minute hand touches an even minute, and pour on the developer. At the same instant begin to count seconds, rock the dish, watch the creamy surface of the plate closely, and the moment any trace of the image (the high lights) begin to appear note the number of seconds counted. Cover up the dish. This number (the time of appearance) multiplied by the factor gives the total time for development from the commencement. Rock occasionally to prevent markings, but do not rock all the time. When the calculated time has elapsed, pour the developer out of the dish and rinse the plate from a jug or under a tap. There is no advantage in much washing at this stage—a quick swill is enough.

The factorial calculator is most convenient for the multiplying process, as it is set beforehand for the factor and the development time is instantly read against appearance.

Development with Dark Room Clock.—Mix the developer ready. Place the plate in the dish, wind up the clock, wait until the second hand touches the figure 0 and then stop the clock by pressing the side lever upwards, then set the minute hand (by means of the button at the back) forward, never backward, until at 0. (Take no notice of the second hand moving on a second or so.) Start the clock by pressing the lever down, and at the same moment pour on the developer. Watch the plate carefully (rocking the dish once or twice) and the moment the high lights are seen emerging from the creamy plate, stop the clock by pressing the lever upwards. Observe the number of seconds (time of appearance) the seconds hand point at, and start the clock again as quickly as possible, as it is required to be kept going so as to record the total time of development. (Some users will find it possible to observe the time of appearance in seconds without stopping the clock. If the time of appearance is long it can be noted by the minute hand.) It is now necessary to multiply the time of appearance by the factor proper to the developer used; and to do it as quickly as possible.

To use the Factorial Calculator.—Set the pointer marked Factor to the Watkins factor proper for the developer. Look out on the inner scale the time of appearance in seconds (if under 60 seconds) or in minutes (if 1 minute or over), and then against this figure there will be found on the outer scale the total number of minutes to develop. Set the moveable indicator or finger on the front glass of the clock to this figure.

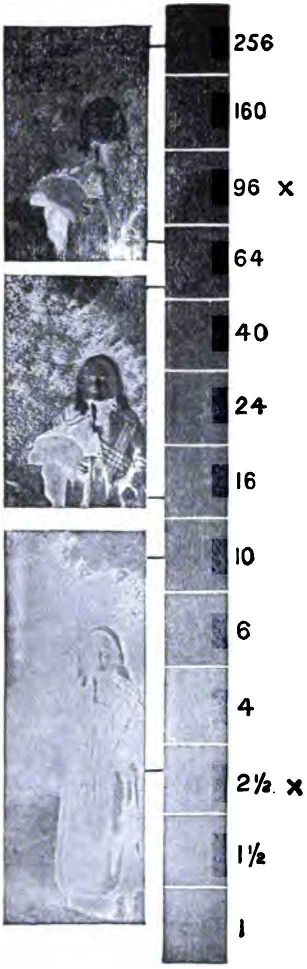


Fig. 5. Limitations of Plate.
Full scale of tones. Also showing how an underexposed, correctly exposed, and overexposed negative utilize these tones.
See page 27.

and when the minute hand (the stouter hand) reaches this, development is complete, and the plate can be at once rinsed with water and fixed in the usual way. If the developing dish is carefully covered when using the calculator, a light may be struck or the gas turned up to use the instrument.

The Watkins Factor.—This expresses the experience or choice of the photographer in the degree of contrast he wants in the negative. It must be clearly understood that although I give definite figures for different developers they are a guide for the first trial only, and may require modification to suit other photographer's fancy as regards contrast. It must also be remembered that the best amount of contrast (or steepness of gradation) for one printing process is probably not the best for another, and here, again, the experience of an old photographer may lead him to modify the factor. To the beginner, however, I think I can promise a fair printing negative with the factors I give, if the exposure is within limits.

When once the right factor is found, it need seldom be altered. Do not judge by the "density" of negative alone, but by the contrast in the finished print.

If the suggested factor gives too much contrast, use a shorter one in future. If the print has not enough contrast (is too grey or flat) use a longer factor next time. The standard factor should give the *same contrast* in the print as appeared in the subject, and if it is desired to exaggerate or minimize the contrast a change of factor gives the required result with ease and certainty.

In this and the thermo system the exposure decides the density of the negative, and the length of development the contrast between the tones.

Do not attempt to regulate the density of negative by development, but follow the system, and you will find that if through errors of exposure some negatives are thinner than others there will be a surprising uniformity of resulting prints. As an example of this see Figs. 28 and 29. The table of factors I give is enough to serve as a guide, and I am really compelled to hint that its publication does not imply my willingness to mix up and test every one of the hundreds of formulæ published, and of which examples reach me on post cards with the words, "thanking you in anticipation" added. Any one has the same power that I have of working out grains to ounce of pyro in a special developer, and then finding its factor in the table I give.

It may happen that there is no white part or high light in the subject you are developing (stone work, for instance, with no sky appearing). In such a case note the first appearance as usual, but take 3/5ths this for calculating, for the high light if it had been there would have appeared in 3/5ths the time.

With interiors, a window, if included, is usually greatly over-exposed, therefore let the appearance of this pass and take the next high light appearing.

For sky negatives, in which a soft effect is wanted, use a shorter factor—say ⅔rds—than the standard one. In snow scenes also a rather shorter factor than usual might be used. With these exceptions I doubt if there is any need to vary the factor for different classes of subject.

SUGGESTED WATKINS FACTORS.

(Grains to oz. means grains of the solid substance to the fluid oz. of completed developer.)

	Grains pyro to oz.	Factor.
Pyro-Soda without Bromide	1	18
	2	12 (div. 5)
	3	10 (div. 6)
	4	8
	5	6½

	Grains pyro to oz.	Grains bromide to oz.	Factor
Pyro-Soda with Bromide	1	¼	9
	2	½	5 (div. 12)
	3	¾	4½
	4	1	4 (div. 15)
	8	2	3¼

Pyro-Acetone about double the above figures.

	Factor.	
Adurol (Schering or Hauff)	5	(div. 12)
Kachin	10	(div. 6)
Pyrocatechin	10	(div. 6)
Hydroquinone (minimum bromide)	5	(div. 12)
“ (maximum bromide)	4½	
Eikonogen	9	
Metol	30	(div. 2)
Glycin (Carb. Soda)	8	
“ (Carb. Potash)	12	(div. 5)
Paramidophenol	16	
Certinal	30	(div. 2)
Amidol (2 grains)	18	
Rodinal	40	
Ortol	10	(div. 6)
Imogen Sulphite	6	(div. 10)
Diogen	12	(div. 5)
Edinol	20	(div. 3)
Quinomet	30	(div. 2)
*Pyro-Metol (Imperial Standard)	9	
*Metol Hydroquinone	14	
Kodak Powders	18	
Victol	40	

Factors for Pyro-Soda.—In cases where the factor will divide evenly into 60, calculation of time of development is much simplified, as the product (called the *divisor*) can be used to divide the *seconds* appearance in order to obtain the *minutes* to develop.

In previous editions I have given estimated factors for the formulæ of plate makers. I am discontinuing this, as most of them are practically the same formulæ, and in any case a personal trial is wanted before a factor is decided upon.

At least two-thirds the formulæ are 2¾ grains pyro to the oz. (in most cases 1 oz. pyro made up to 80 oz. water for No. 1) and the Watkins Factor for all these will be approximately

5 if *with bromide.*
11 if *without* bromide.

In fact it will be well to make a first trial with one of these factors with *any* pyro-soda developer, and alter according to results. I give a few exceptions from this 2¾ grain list.

	Factor
Criterion (1½ grain)	7
Gem (1¼ grain)	8
Ilford (max. pyro)	4½
" (min. pyro)	5½
Kodak Film (1½ no. b)	15 (div. 4)
Wellington Studio (1¼ no. b)	16

I regret that I cannot supply factors for the innumerable developers not here mentioned. The sellers would greatly assist their customers by printing the factor on the label, and several firms already do so.

Factors for Combination Developers.—The factor is, approximately, the average of the two constituents, if in equal parts. Thus with hydroquinone (5) and metol (30) the average would be 17½. But if the combined developer contains two parts of hydroquinone to one part of metol (three parts in all) you put down the factor for each of the three parts and divide by three, thus:—

$$\frac{5 + 5 + 30}{3} = 13\tfrac{1}{3}$$

But a combination developer containing pyro does not conform to this rule and its factor must be ascertained by actual trial.

What alters the Factor.—With pyro (as with amidol) the factor varies with the strength in grains to the ounce. But in all other developers, as far as I know, the factor does not alter with strength or dilution.

The use of bromide (or its omission) alters the factor greatly with pyro, and, probably, with short factor developers, such as hydroquinone. With high factor developers, as metol, I canont find it has much effect.

Variations in the amount of alkali in the developer does not alter the factor.

As a general rule, a factor which is right for one plate or film is also right for another plate or film. It is true that some plates develop much more quickly than others, but the time of appearance makes allowance for this. I have often, after testing six different makes of plates for their speed, exposed them in accordance with their speed, and then developed them with the same factor. In almost all cases I secure six negatives which are practically identical, although some have (in accordance with time of appearance) to be developed longer than others. A double emulsion, as in the Cristoid film, seems to call for a much higher factor than a single one.

A few exceptional plates (which appear to contain more iodide) require factors one-half greater than usual.

Calculating Factor from Formula.—I give in the table factors for certain amounts of pyro to the ounce both with and without bromide. In order that enquirers shall be able to work out the grains to ounce of their particular fad (and not expect an overdone experimenter to their sums for them), I give the rule to follow:—Take the total quantity of water in No. 1 or A solution, add to this the relative proportion of No. 2 or water which is required to make the complete developer, and then divide this quantity of liquid into the full amount of pyro given for the No. 1 or A solution. The result is the grains of pyro to ounce of developer.

Example:—In the Cadett pyro-soda developer a stock solution of pyro is prepared by making up 1 oz. (437 grains) of pyro to 10 oz. of water. But only 3 oz. of this is used to make the A solution, which, therefore, contains 3-10 of 437, or 131·1 grains. The A solution is 20 oz. in bulk, and to make the complete developer an "equal part" of B solution (that is, another 20 oz.) has to be added, the 131·1 grains of pyro is, therefore, distributed in 40 oz. of developer, which gives 3·27 grains to the ounce. Consult the table of factors for pyro-soda no bromide. 3 grain pyro is factor 10, and 4 grain factor 8. The factor for Cadett pyro-soda with no bromide will, therefore, be about 9.

Simplifying Calculation.—The total time of development can more easily be calculated if such a developer be used that its factor divides evenly into 60, the product being then used to divide the *seconds* appearance in order to obtain the number of *minutes* to develop. The divisions are indicated opposite the factors in the table.

Thus factor 6 is one-tenth 60, and one-tenth the seconds' appearance will be the number of minutes to develop. This has become a favourite plan under the name of the sextuple method, it being so easy to translate 40 minutes appear into 4 minutes develop. Or the pyro-soda formula as given without bromide can be used with factor 12, which is one-fifth of 60; and one-fifth the number of seconds appearance will be the number of minutes to develop.

To follow this plan rigidly, pyro is the only suitable developer, as greater or less contrast can be secured with the same factor by using a greater or less proportion of the No. 1 (pyro) solution to the No. 2 than the usual half and half.

Metol (factor 30) would require *one-half*. The seconds appear for the development in minutes, but control over contrast could only be obtained by giving more or less time than the calculated time, and not by altering the developer.

Pendulum.—If the dark-room clock is not used, a half-second pendulum will be found a most convenient help in counting seconds for noting time of appearance in the dark room. It can be made by fastening a bullet to a chain or string 9½ to 10 inches long. It can be held in the fingers or suspended from a shelf, seconds being counted at *one end* of the swing.

Applicable to Both Methods

Treatment for Exposure Variations.—It used to be considered that when in developing a negative the tones appeared in rapid sequence, and all veiled over (an indication of over exposure), the best procedure was to add a strong restrainer—usually bromide of potassium—or mix up a new strong developer containing bromide, the idea being that the bromide held back the lower tones while density was built up in the high lights. It is now known that while bromide keeps back the lower tones from appearing for a time (lessens the speed of the plate) its power has gone *after the lower tones have once appeared,* and that the above procedure was useless. It is true that known cases of over exposure can be successfully treated by using *from the commencement* a low factor developer with plenty of bromide, as the lower tones are held back until sufficient density (contrast) is produced. Strong pyro (4 grains to 8 grains) or hydroquinone is the best for this purpose.

As over exposure is not usually known until all the tones have appeared, bromide has in actual practice very little power as it is too late to alter the developer, and equally good results can be obtained by developing to the full extent indicated by the factor, and by no means taking out the negative earlier.

There is a very curious tendency amongst photographers (entirely overcome by timing development) to take over exposed negatives out of the developer much earlier than correctly exposed ones. So general is this practice that it is usually supposed that thinness of negative is a result of over exposure.

The thinness simply results from under development.

Make the following experiment—Expose a plate on a subject for a correct time, say 1 second, push the slide in a bit and expose 1 second more, push in again and expose 2 seconds, then again for 4. You will have the exposures of 1, 2, 4, 8 seconds on the plate. Develop the plate, and you will be cured once for all of any idea that over exposure gives thinness, for the density of each section will be greater than the exposure below it. And now comes a remarkable fact. If the plate is a good one, the 4 second and even the 8 second exposure will, although dense and taking a longer time to print, yield a print practically identical with the 1 second exposure, if both exposures are within the latitude of the plate.

In Fig. 28 (page 80) the exposure was ½-second, and it was developed with the pyro developer for 13 times appearance.

In Fig. 29, with the same plate, light, and stop 4 seconds were given, and this also was developed with a factor of 13. The first is much the thinner negative, and takes a shorter time to print, but the gradation of the two are practically alike.

With some plates (usually not rapid ones) the latitude of exposure is so great that a variation of 1 to 20 may be made. It all depends upon the quality of the film, but there is always a limit *below* which detail is hopelessly under exposed, and another limit *above* which all the upper tones have equal densities, giving the familiar grey appearance of over exposure. The medium between these extremes is correct exposure. Some plates are so poor in quality (have so short a latitude) that no variation of exposure at all is permissible for best results.

As regards treatment for under exposure, absolutely nothing can be done if a developer with no bromide is being used, and the under exposure is not known until the development commences. The great thing to avoid is over development, and there is no danger of this if the time method is followed. It is absolutely useless to push on development beyond the time, or to add more alkali, or to dilute the developer in the vain idea of "bringing out detail." The only result of pushing on development is to produce over contrast and (as regards the final print) destroy the faint detail. Be content with the thin negative which the time method produces; it will give a far better print than if you had developed longer. Look at the "soot and whitewash" effect of most snapshot prints, and you may judge how universal is the error of developing under exposures too far. If under exposure is known beforehand, wonders can be effected by heat in development.

I cannot too forcibly express the point that all unrestrained developers being out of all detail capable of appearing at that temperature, *before the time indicated by the factor has elapsed.*

The moral of all this is to keep to one formula of developer for all your exposures, and if you get some thin and some dense you may take it as a lesson to be more careful in exposure; but *do not attempt to get uniformity of density by varying time of development.*

Where an actinometer and reasonable care is used in exposure; landscapes, interiors, and snapshots may all be developed together in one dish for the same time with excellent results; the time of appearance being taken from the average high light, not from an exceptional one like the over exposed window in an interior.

There is a theoretical defect in factorial development, in that it gives slightly different times to over and under-exposed plates, whereas the correct procedure is to give them the same time. This defect has not been found a serious drawback simply because the users of the method have also usually ensured a tolerable uniformity of exposure by using a meter.

Exhausting a Developer.—It must be kept in mind that a grain of developing salt is able to "reduce" (or develop) only a certain amount of silver particles in the film, and that when it has done this maximum it is absolutely without further power. All the principles I have enunciated presume that here is an ample surplus of unexhausted developing salt present to do all the work.

It is, therefore, important not to stint the quantity of developer used, especially if it is a weak one. Probably with a 2 grain pyro developer not less than 1oz. is a safe quantity for a quarter plate (and for certainty in covering the plate 1½oz. is better). If for any special reason a ½-grain to 1oz. developer is used, the quantity should be increased to 4 ounces for the quarter plate. When a developer is used over again its energy is, of course, partially exhausted, and the bromide set free in the reduction of the silver also alters its composition. Timing by appearance makes approximately correct allowance for this alteration, but a pyro developer should not be used a second time. The other developers may be used a second time, but the idea of using any developer "over and over again" should never be entertained. It is quite possible to use a developer so stinted in active developing salt that when a weak stage of contrast is attained in the negative, no further work is done; and a feeble negative results. It is especially easy to make this mistake when developing a roll of films.

Film Development.—The flat celluloid films (the comparatively thick ones) are treated exactly as glass plates, except that extra care should be taken to see that they are covered by developer all the time.

Rollable celluloid films require special treatment, for in my experience even the modern "non curling" films previously soaked in water do not lie flat in the dish, and if developed without a holder require a large amount of solution and frequent application of the fingers to keep them under. There are several contrivances to keep such films flat during development. One is to take a plate a trifle larger than the negative, rough the edges by scraping another plate against them (for if this is not done they will cut the band) and secure the film to the plate by a rubber band at each end.

But of late years the see-saw plan of developing the whole roll at once without cutting up has become almost universal.

The whole 12 exposures are developed in one strip, if they are small ones, and half the length if over quarter plate. Provide a couple of bowls, small basins, or finger glasses large enough to have a fairly flat bottom as wide as the film. Fill one of these with water, and in the other put at least six times as much developer as required for a single negative of the size. Uncoil the roll, take two American wooden clips to hold the ends, and hold the length in a **U** shaped loop (film upwards). Dip the loop in the basin of water, and with a see-saw motion, raising one hand as the other is dropped, pass the whole of the film through the water to wet it.

Note the time, and in the same way pass the length of film through the developer, beginning to count seconds at first dip. Of course, only one part of the film is under the developer at a time, but the see-saw motion, which is never ceased for a moment, treats all parts alike. Note the time of appearance, and continue development in accordance with the usual multiplying factor, or time by the thermo method. Then pass through the water again and fix.

The modern developing machines are merely a refinement of the see-saw plan obviating the need of a dark room. There are several convenient roller contrivances and developing weights to be bought which facilitate the see-saw method.

With most plates and films the surface of the film is seldom touched when under the developer; except in some cases with a camel hair mop to remove air bubbles. There is one advantage of films (of all kinds, except the thickest celluloid) which is not generally recognized. They may be printed from both sides, and, therefore, if printed from the reverse side give non-reversed prints in carbon by single transfer. Single transfer carbon is one of the simplest of all printing processes, and a most satisfactory one.

Local Development.—Many photographers have been very successful in securing clouds and sky effects in the negative by "holding back" that part of the plate by the local application of a bromide.

There is no reason why this should interfere with the timing method. Have ready to hand a cup containing half an ounce of water and 1 dram 10 per cent, bromide solution, also a camel hair mop or brush.

Time development as usual, but at about half time, tilt the dish that the sky may be upwards and out of the developer, and paint over the sky part with the bromide solution, keep the dish tilted so as to just cover the sky line with the developer, and complete the calculated time.

Temperature.—The factorial method makes correct allowance for ordinary changes of temperature—say, from 45° to 75°.

It is best to avoid developing below 45°, as some developers—as hydroquinone—work very slowly at this limit. Temperatures over, say, 75° also lead to difficulties, and should be avoided except where climate makes it inevitable. For tropical climates special plates are generally selected, Messrs. Wrattan having an old reputation in this matter.

Heated Development for Under Exposure—The speed of a plate can be greatly increased by this means. But it is not use merely pouring on a warm developer for the reason stated above. The plate and dish *must* be warmed up to the same degree before developer is poured on. A warm water bath with small burner underneath is probably the most convenient method of warming, and the degree of heat will probably necessitate a few failures to ascertain. But a preliminary preparation of the plate is absolutely necessary or it will frill or dissolve. Mr. Gus. Edwards (who has had marvellous success with apparently hopeless under exposures) "edges" the plate by drawing a composite candle round the edge of the film. Mr. C. Moss uses diluted formalin to harden the film beforehand. The latter plan is, probably, the best.

"Betwixt Two Stools."—The time methods of developing aim at the same control which older methods attempted by all kinds of modifications of strength and alkali and bromide, these changes (as in tentative development) being often advised after the image appears.

But I must warn those who still cling to the merits of modifying the developer, that the two plans will not mix. Keep to the one plan or the other, and not fall to the ground between the two. If you time development, never look at the plate to judge density in the old way, and never alter the developer after pouring on. I do not claim that the old methods and instructions are wrong, but that they are cumbersome, that they obscure the simple principles of development, and provide no means of conveying *exact* information from expert to beginner.

Rocking the Dish.—If the dish is continually rocked during the whole time of development, the steepness or gradation will be greater than if not rocked. In other words, rocking alters the factor, and, perhaps, the speed of plate also to some degree. It is best to get in the habit of rocking two or three times until the image appears, and then about twice during the remaining time.

Just a tilt of the dish is enough to prevent mottling or marking.

Halation. —This is the spreading of the image where a strong high light comes against shadow detail, as in the window of an interior, or sky against branches of trees. It gives a misty, smoke-like effect to what ought to be sharp, dark edges in the print. It occurs most often with glass negatives, the back surface of glass reflecting back light to the wrong side of the film. There are several paste-like "backing compositions" to be had, which, spread on the back of the plate before exposure, prevents the evil. For interior work "backed plates" are almost a necessity, and many now expose none but backed plates, as it is not easy to know when one is wanted. Makers now supply ready backed plates. Backing does not alter the speed. Celluloid films are much more free from halation than plates.

Intensification.—When, after the negative is fixed and printed from, it is found that in consequence of too short a factor having been used, there is not enough contrast in the print, which is "grey" or "flat," the remedy is to intensify the negative. This usually gives the same result as if development had continued longer.

The Burroughs Wellcome Tabloid Intensifier (mercuric iodide and sodium sulphite) is, perhaps, as convenient a form as any, for any reasonable degree of intensification can be attained by length of soaking, or amount used.

I have found it convenient to decide upon amount of intensification by apportioning the *amount* of tabloid to one plate, dissolving that amount in enough water to cover the plate in the dish (taking no notice of strength given in instructions) and simply leaving the plate in until the action of intensifying is exhausted, rocking the dish now and again. Thus:—One-tabloid in 2½oz. of water strongly intensifies a half plate; half a tabloid in 2½oz. gives a moderate increase of contrast; and a quarter tabloid a slight strengthening.

In my experience, this and other single solution intensifiers must be thrown away after once used. The plate must of course be washed after intensifying, but it is a peculiarity with this formula that intensifying may take place with very slightly washing after the fixing bath.

The ordinary mercury intensifier is also efficient; with it the image is whitened throughout the thickness of the film with the mercury solution, and then blackened with an alkali or a developer.

It does not do to *partially* whiten the film, as the shadow detail is then fully intensified, and the high lights only partially, nor does it do to partially blacken the film for a similar reason. The degree of intensification can only be decided by selecting the blackening solution. Thus:—Sodium Sulphite (½oz. to 10oz. water) gives the least contrast, one of the ordinary developers such as metol-hydro-quinone, a considerable contrast or intensification, and for the most violent intensification ½oz. liquid ammonia to 10oz. water must be used for the blackening solution.

BLEACHING SOLUTION

(Which can be used over and over again).

Corrosive Sublimate	¼oz.
Water	20oz.

This takes a long time to dissolve, but is quickly done if a little ammonium chloride is added.

The negative, after thorough washing, is soaked in this until the high lights are whitened through to the back, it is then *thoroughly* washed for some hours in running water, *exposed to daylight for a few minutes,* and (for the medium amount of intensification) blackened in any usual developing solution, except pyro-soda. A moderate washing completes the process.

The need for intensification must be decided by the need for contrast in the print. Never intensify simply because the negative appears thin. Many a thin-looking snapshot negative, with only enough exposure to give a suggestion of shadow detail, would print in violent contrast, and be, therefore, ruined by intensification.

Reduction.—Just as intensification adds to the various tones in due proportion, and increases contrast, just like a continuation of development; so a perfect reducer is an undoing of part of the course of development, the tones being reduced in their proper proportion, and less contrast resulting. A few years ago a perfect reducer was unknown, but ammonium persulphate has since come into use.

When, therefore, too large a factor has been used in developing, and the resulting print shows over contrast, the negative should be reduced with ammonium persulphate. Burroughs Wellcome Tabloids provide a convenient form for use. It is absolutely necessary to have in a dish at hand a dilute solution of sodium sulphite (strength not particular), which immediately stops the action. It has been pointed out that reduction with ammonium persulphate can be timed by a *factorial* method, and this is strongly advised to indicate "when to stop." The solution turns slightly milkly as soon as it begins to act. The time between putting the plate in the reducer and the first indication of milkiness is called the "time of appearance." The factor to use is 3 for slight reduction, 4 for considerable reduction. Thus if the reducer shows milkiness in two minutes leave it in a total of either six or eight minutes, rinse quickly and place in the sulphite bath, then wash.

The older Howard Farmer reducer is useful in its way, but it eats out the shadow detail more than the high lights, and while reducing does *not* reduce contrast as a rule. Where a negative is over exposed and very dense it is valuable, and a slight application will clear away fog. To prepare it, dissolve 1oz. of potassium ferricyanide (the *red* prussiate of potash) in 10 oz. of water. Keep this in the dark. Make a weak solution of hypo (clean fixing bath with its own bulk of water). Add the ferricyanide a few drops at a time until it is a pale sherry color. Immerse the negative in this and watch its action closely. Wash well.

In lantern slide making, the weak point of the Howard Farmer reducer (which, by the way, only keeps for one plate) makes it valuable where eating away the lower tones is a result to be aimed at.

Judging Over or Under Exposure.—Where time development is kept to, this is easy, as the under exposed will be unduly thin throughout, and the over exposed unduly dense. But with haphazard development it is not so easy. However, in an *under exposed* negative (which may be thin and bright or dense and foggy) the *detail* in *shadow* parts is wanting; an over-exposed negative may be thin (in which case there is little contrast) or it may be dense. But in any case there is a want of detail in the upper tones and high lights, which all have a grey appearance on account of the want of contrast in that part.

Defects and their Causes.—Small bright spots peppered over the high lights of the negative.—These are pinholes due to dust. Remedy—Dust the plate before exposure and before development.

Larger circular markings with sharp edges.—These are air bubbles which remain on the plate after the developer is poured on. Remedy—Pour on gently, and brush surface of plate with a camel hair brush.

Markings of larger size, like ponds or lakes.—Cause—Imperfect flow of developer over the plate. Remedy—More developer, more care.

Mottling on negative.—Cause—Want of rocking the dish.

Fog.—Cause—Imperfect dark room light or too long exposure to it. When from this cause fog is fairly uniform over the plate, and covers the edges caused by rebates of slide. Or a rapid plate kept too long.

Local fog.—Over part of the plate, or radiating from one corner. Cause—A leaky dark slide, camera, or plate box.

Constituents of the Developer

The active part of the modern developer is the developing salt, which is usually a definite chemical, not a mixture. Pyrogallis Acid—always called pyro for short—is the old favorite. Used with plenty of sodium sulphite it gives a black image, but as usually mixed up the color tends to a brown or yellow brown. This is due to part of the image being a yellow "pyro stain," which does not extend to the "clear glass" part of the image, and is (contrary to general opinion) absolutely unaffected by any "clearing solution." Some plates give more of this stain than others, and there is no objection to its presence, except that the brown image (compounded of the black silver and yellow pyro stain) does not intensify or reduce so readily as a pure silver image.

Pyro is more apt to stain the fingers than other developers. Practically all the newer developing salts (from hydroquinone to kachin) give a black or grey image. Their differences have already been dealt with, but with some constitutions metol has an irritating effect on the fingers, which can be obviated by anointing them with vaseline before developing.

All these salts are soluble in water, but in most cases (and I do not advise the exceptions for negative work) a simple solution is not an active developer, and an alkali must be used. Experience has shown that there is no advantage using more than a certain quantity of the salt to the ounce—the maximum useful working amount for pyro being about 4 grains to the ounce. On the other hand, a very weak solution takes a troublesomely long time to do its work, and pyro is seldom used weaker than 1 grain to the ounce, the average being 2 grains. Within these limits the activity of the developer will be about in proportion to its strength in developing salt, the proportion of alkali to developing salt remaining the same. For example, dilute a 2 grain pyro developer, no bromide, with its own bulk, and it will take double the time or a trifle more to attain the same result.

Alkali.— Sodium carbonate (be careful to avoid the household "carbonate," which is bicarbonate, and useless) is now generally used, and has no disadvantages. It is best to get it in crystals from the chemists. Common washing soda is often sufficiently pure, but is sometimes seriously adulterated with sodium sulphate, which acts as a restrainer and alters the factor.

From 6 to 12 times the weight of the developing salt is the useful limit with "soda." The activity of the developer varies with the amount of alkali, but within usual limits identically the same result is attained, whether weak or strong, if the same multiplying factor is used.

Potassium carbonate (potash) is another useful alkali, and a trifle over half the quantity as with soda is required.

The caustic alkalies (sodium hydrate and potassium hydrate) are powerful, but objectionable. They corrode the glass stoppers and the fingers, and soften the gelatine. Hydroquinone seems to be the only salt requiring such powerful aid, but when it is used in combination with metol, sodium carbonate is quite strong enough.

Sulphite.—The presence of sodium sulphite (in excess) prevents the formation of the yellow pyro stain, and therefore with pyro keeps the image black. It also tends to keep the developer from discoloring when in the alkaline condition. With bromide papers it also tends to give a blacker tone.

Chapman Jones has pointed out that the proportion of sulphite (about 20 grains to ounce to give a black image) should be invariable to the bulk of the developer; and not to the developing salt. This is probably the reason why a weak pyro developer is more prone to stain than a strong one. In the pyro developer I give, I have not included enough sulphite to give quite a black image.

Proportions of the Constituents.—The makers' formulæ are usually pretty safe, although the complex way in which several are given is a perpetual source of wonder, the object seeming to be to baffle the unfortunate enquirer who strives to ascertain how many grains of pyro he uses to the ounce of complete developer.

The Editor's commonplace that it is "best to use the developer recommended by the maker" is safe enough, and a neat way of shifting responsibility to strong shoulders, but when developing is timed I am unable to discover any advantage in using special developers to special plates. I find one formula equally efficient with all.

Bromides.—The user of a restrainer, such as bromide of potassium, is a legacy left from the days of pyro—ammonia development. Its use introduces complication and variation from the usual simple course of development, without sufficient compensation, and with a good modern plate and sodium carbonate as the alkali, it can be omitted from the developer and only used in exceptional cases, where it is desired to "hold back" the lowest tones or fog. Let me illustrate this "holding back" power. Fig. 30 represents four steps of gradation produced by, say, 5 minutes development without bromide. The lower diagram gives an idea of the result of the same exposure if the same developer, with a little bromide added, is used for the same length of time. It will be seen that the *steepness* of gradation (and, therefore, the contrast in the print) is identical whether bromide is used or not. But the addition of bromide has retarded all the tones and prevented the lowest tone from appearing at all. It has, in fact (at this stage), reduced the speed of the plate. If, however, development with bromide is continued to a greater steepness of gradation, the tone A will develop out, and in due time take exactly the same place as if no bromide was used.

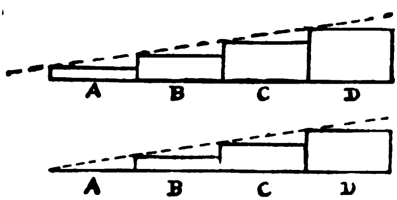


Fig. 30

To utilize the restraining power of a bromide therefore, development must be terminated while the "holding back power" is still in force.

We owe our knowledge of these facts, and of all the main principles of development, to Messrs. Hurter and Driffield.

With high factor developers (metol and weak pyro) the lower tones come out so early in development that the holding back power of bromide is exhausted before a useful degree of contrast is attained, and bromide is of very little use with this class.

But if a low factor developer (hydroquinone and strong pyro) is used, the tones naturally come out very late in development, and with the extra holding back power of bromide the lower tones have not appeared or have only begun to develop when a useful steepness of gradation is reached; and with this class of developers, therefore, bromide decidedly alters results.

It is with a low factor developer and plenty of bromide that gross over exposure can be made to yield good negatives. But when once the tones have appeared it is quite useless to add a bromide with the idea of holding back fog or the lower tones.

A consideration of this peculiar action of bromide explains why old photographers, using pyro-soda with bromide, find they get a softer effect with a diluted developer than with a strong one. With the strong pyro-soda the development has reached a good printing stage, and was taken out while the lower tones were still held back by the bromide.

The same developer diluted required a much longer factor to reach the same steepness of gradation, and a much longer time; when taken out the holding back stage was passed, and the lower tones developed out just as if no bromide was used. Greater softness, therefore, resulted, especially as the tendency with slow development is to take out the plate too soon.

With pyro-soda from ⅛th to ¼ the amount of pyro is the usual proportion of bromide used.

With high factor developers bromide has practically little result, except to slow development.

Bromide certainly alters the factor with pyro, and probably with other low factor developers.

The use of bromide in the developer almost always decreases the working speed of the plate by the holding back influence. But an exceptional plate is occasionally found with which bromide actually *increases* the plate speed.

Calculating Factor with Bromide.—I will suppose that you are using a pyro developer, and from practical experience have found the factor which gives a stan dard result. You now want to use the same developer with some change *as regards bromide alone* (either to omit it, or to add it, or vary it). Fortunately, a discovery of Hurter and Driffield enables you to find the factor with one simple trial. The basis is the fact that the two developers at equal temperature will give the same steepness of gradation in the same time. Expose a plate, cut in two (or expose two plates), made up the two developers alike, except as regards bromide. Notice the time of appearance of your known developer (say ½-minute) and multiply by your usual factor (say 10). Five minutes would be the complete time, but you need not develop. Test the other test plate in the new modified developer, and note the time of appearance—say 1 minute. Divide the full time—5 minutes—by the new time of appearance, and the result will be the new factor; in this case 5.

Stale Plates.—It is an unfortunate fact that some rapid plates and some ortho plates will not keep, but "go off" perhaps six months or 12 months after manufacture. If used in this state only weak and foggy negatives result, and length of devlopment will not give the contrast required.

In other cases of good plates several years old, they develop slower than usual, and the time of appearance makes the necessary allowance. Plates should be kept in a dry room where gas is not used for light or heat.

Factor Variations for Different Processes.—Stereoscopic negatives should always have soft contrast, and factors 1-5th less than the average will be about right. The same applies to negatives for three color work, where the *contrast* between the colors depends upon the factor used for development, which should be about 1-5th less than the average.

Where three different brands of plates are used for the three colors, equal factors or a slightly lower factor for the red will give equal contrast in all three—a most important matter.

The same factor is not always suitable for different printing processes. Both carbon and platinotype may require *slightly* higher factors than P.O.P., although the difference is not great. Some matt and "salted" papers also require higher factors to get the same contrast as P.O.P. would give with a smaller factor.

Summary.—Keep to one plate.

Keep to one formula of developer, of medium multiplying factor.

When exposing, consider only rendering of detail, and leave contrast to development.

When developing, consider only contrast, and leave detail and density to take care of itself. For the same contrast as appears in the subject, keep to your standard factor, or time.

For more contrast than in the subject, increase the factor, or time; for less contrast, decrease.

Make no difference with snapshot negatives to the above procedure; with no bromide you will have brought out all detail possible.

Printing and Toning P. O. P.

Having secured your negative, you are in the position of a printer who has set up a page of type. He is able to print on different kinds of paper or transparent films with ink of any color he may select.

You, too, are now in a position to take any number of prints from your negative, and you have different kinds of paper sold ready prepared to select from.

I am only giving instructions for one printing process—the gelatine chloride P.O.P., not because it is the best, but because it is most generally used, and because I can indicate a method of toning which can be done at night, and will remove some difficulties in this matter where a beginner often goes wrong.

I certainly consider both the carbon and platinum processes superior for artistic work to P.O.P., and almost as easy to learn. The new gaslight papers often offer great advantages for night work, and require no toning. These, however, are outside the limits of this book.

A piece of paper, sensitive to light, is pressed in contact with the negative in a wooden printing frame. This is exposed to daylight until the paper behind the transparent parts of the negative are thoroughly blackened, and a picture the reverse of the negative (see Figs. 1 and 2) produced. If this picture were now exposed to light it would blacken all over, and it, therefore, has to be fixed just like the negative, that is, all the unaltered silver salts dissolved out. But if the print is fixed without a previous process called toning, it is an unpleasant brick red color. The word tone, when applied to a print or positive, means *color,* and to tone is to alter the color of the image by means of special solution or *bath,* as it is called. The usual toning bath contains gold, and toning is the act of depositing metalic gold on the silver image, which alters the tone or color to a brown or purple, "warm" or "cold," in proportion to the amount of gold deposited. Toning must be done before fixing.

Materials and Apparatus.—You will require to purchase:—

Printing frame (size of your negative).
Packet P.O.P. (it is sold in packets cut to size).
15 grain tube chloride of gold (best make).
Two clean 10oz. Medicine bottles. Two clean pyro (20oz.) bottles.
1Oz. sulphacyanide of ammonium in a 10oz. bottle.
The washing and toning dishes I have already mentioned.

Printing.—In a dull corner of a room put the negative, film side up, in the printing frame, open the packet of paper, and place a piece, glossy side (sensitive side), downwards in contact with the film side of the negative, on the back of this place a piece of blotting paper (or better still, American cloth) cut to exact size of the negative, then the hinged wooden back, which secure in its place with the brass springs. Go out of doors and place the printing frame so that the full light of the sky falls upon the glass side.

It may take half an hour in summer, or up to a whole day in winter, but this depends on the density of the negative. You have to examine the progress of the printing now and again by bringing the frame indoors, opening one-half of the back and turning half of the print back to see the face. It must be printed until it is considerably darker than you desire the finished print. About "two shades darker" is the usual approximation. If you expose the printing frame to direct sunshine the printing will be done in about one-third the time, and this is advisable in winter, but the full summer sun makes printing too rapid to be easily controlled. If you have more than one negative to print from, you will probably expose several printing frames at the same time and if you desire several prints from one negative you will print them off before going on to the next stage of the process. Never touch the sensitive side of the paper with the fingers, or you will get stains; always handle the paper by the edges.

Solutions.—Make up the 1 oz. of sulphocyanide to 9 ounces with water.

Label.

10% Sol. Sulphocyanide Amm.

(Use 2 drms. to 10 oz. of bath.)

Break the tube of gold (over white paper to avoid loss), put glass and all in a clear 2oz. measure; fill up to 1½oz., and stir until gold is dissolved, pour into a small clean bottle, then wash out the measure with 3 drachms of water and add to the solution. Keep in dark place.

Label.

Gold—1 grain to 1 drachm.

(Use 1 drachm to 10 oz. of bath.)

Put 2ozs. of table salt into a clean 20oz. bottle (a pyro ottle will do, if well washed) and fill up with water.

Label.

10% Sol. Salt for prints

(Use 1 oz. to 10 oz. of bath.)

Toning Bath.—To 10 oz. of water in a clean bottle add 2 drachms of the sulphocyanide solution and 1oz. salt solution, wash out the measure and add 1 drachm of the gold solution, rinsing out the measure and adding to the bottle. Shake well and label—

Gold Toning Bath

Now, in the older plan of toning, the prints were placed in a full bulk of toning bath and allowed to absorb sufficient gold to give the desired tone. The same bath would be used again for more prints, and it being difficult to tell when the gold was exhausted, prints were often spoilt and complaints made that the bath would not tone. In the newer plan (the principle being introduced by the Eastman Co.), only sufficient bath is used with the prints to contain the gold necessary to tone to the desired color; and the prints are not "over toned" if left in longer than necessary.

The amount of chloride of gold required for each half plate print is 1-10th grain, and this is contained in 1oz. of bath. Toning baths do not keep long.

For every half plate print, therefore (or every two quarter plate prints), one ounce of toning bath is required, of 1½oz. for 7½x5 prints, or 2oz. for each whole plate print. You can use the same method and quantities for any toning bath containing 1 grain of gold to 10oz. For warm tones use half to three-quarters these quantities, adding water to make up bulk.

Toning.—Measure out the right quantity of toning bath according to numbers of prints. Put the dry prints in (without washing) one by one. Keep the prints mov·

ing about in pairs back to back, continually bringing the bottom pair to the top and turning over. If the prints touch each other's face for any time uneven toning will result.

The prints at first are orange, but will gradually change color; when the warm color has vanished from the surface, the print, if seen through, will still be seen to have a warm colored image, and if taken out at this stage would, when fixed, be a nice brown or purple brown tone. To get the required color, however, they are left in longer to absorb all the gold in the bath, the surface changing to a cold slatey tone.

Washing before Fixing.—Pour off and throw away the spent toning bath, and wash under the tap for a few minutes, turning the prints over.

Fixing.—The same stock solution of hypo you have already made up for negatives will do, if diluted with an equal bulk of luke warm water, or make up a new solution of 2oz. hypo to 20oz. of water. Always dilute or dissolve hypo some hours before it is needed to get an equable temperature. Of course the hypo bath must be clean, not used before for negatives, and it is convenient, although not necessary, to have two fixing dishes, one for negatives, the other for prints. Immerse the prints one by one, rocking the dish, keep turning them over, bringing the bottom ones to the top. About 10 minutes is the time for the fixing bath, if left in too long the prints go ligher in color. Do not begin to fix until all your toning is done, and religiously keep the hypo away from the toning dishes. After dipping your fingers in hypo, wash them well. All this prevents mysterious red stains appearing on your prints.

Washing.—If every trace of hypo is not washed out of the prints, they will inevitably fade. Prints should be washed in running water for several hours. It is not enough to merely soak them in water for that time, but the water must be changed many times, and the prints moved about, not allowed to settle at the bottom of the dish for long together. If you wash in a dish or vessel under the drip from a tap, the water must fall in a corner of the vessel where no prints are, or the falling water will wear holes in the prints. With this method you must empty the vessel 3 or 4 times (especially at first) or the hypo washed out will merely fall to the bottom. You must also change the prints about, bringing the lower ones to the top. If you buy a special appliance for washing prints, avoid a metal dish or tank. A porcelain vessel will outlive a dozen metal ones.

Drying.—Lay the prints face upwards on a sheet of newspaper, and put in a warm room free from dust.

Appendix

TABLE OF DIAPHRAGM VALUES.

The columns show equivalent values opposite each other. The "special" Kodaks with R.R. lenses are marked with U.S. numbers (the English Uniform System, not United States as so many presume), the values of which are here given. The D column is the Watkins number for calculation with simple actinometer. Dallmeyer's lenses earlier than No. 43,000 do not bear the numbers.

U.S.	D.		Dallmeyer's Nos.	Goerg. Stolze No.	Congress No.	Zeiss New No.
256	64	F/64	400	...	...	...
192	48	F/56	300	...	...	1
128	32	F/45	200	192	...	...
96	24	F/40	150	...	16	...
64	16	F/32	100	96	...	2
48	12	F/28	75	...	8	...
32	8	F/22	50	48	...	4
24	6	F/20	40	...	4	8
16	4	F/16	25	24	...	...
12	3	F/14	20	...	2	16
8	2	F/11	15	12	...	...
6	1½	F/10	10	...	1	32
4	1	F/8	7.5	6	0.7	...
3	..	F/7	5	4.6	...	64
2	..	F/56	3	...	...	...
...	..	F/5	2.5	...	...	128
1	..	F/4	1.5	...	...	...

Standards of Speed.—It is impossible to speak of the speed of a plate without comparing it with something else. The first comparison made when the dry plate first came in was a rough one with the old wet plate, and the new plates were sold as "thirty times" or "sixty times" the speed of the old, the branding by x's having the same meaning. Then Warneke invented his sensitometer having opacities numbered from 1 to 25, the speed being read by the highest opacity through which any light action took place when exposed to a standard light. Different speeds could be read by modifying the developer. But condemnation on this point is not fair to the memory of Mr. Warneke, for with our present knowledge of the "holding back" properties of bromide we know that a developer without bromide is a necessity for accurate speed testing by *any* method. The Warneke method of observing the lowest tone, combined with the far more accurate *exposing* apparatus of Messrs. Hurter and Driffield, is now combined in the Scheiner method used in Germany, but not in England.

The Hurter and Driffield speed testing method is far in advance of any other published, and practically all our knowledge of speed is based upon their work. In their method, geometrically increasing exposures are given to different parts of a plate, and the speed is read by making a diagram of the resulting images, and noting which part of the series have regularly increasing densities.

In their speed numbers, 50 requires twice the exposure of 100, and 100 twice the exposure of 200. The inventors have taken great pains to define the developer and the standard light to be used for the test, but the difficulty in the latter respect has been too great, and as a matter of fact H. & D. speed numbers (quite apart from the "commercial difficulty" to which I shall refer) have *not* a standard value in comparing the numbers marked on one maker's box with those marked on another's. When the H. & D. number is printed permanently as part of the regular label, and does not vary with different batches, it is merely a vague trade term which has no more value than the words, "Extra Rapid."

The Commercial Difficulty.—Unfortunately, makers have—for advertising purposes—foolishly fostered the idea that the most rapid plates are the best to use, and placard the pages of the journals with statements of the "quickest plates made."

These makers, therefore, if they quote speed numbers. desire that they should support their claims and not clash with them. The users of plates want speed numbers for an entirely different object, merely that they should be able to expose correctly, and a sensible man who gets this information does not worry for higher speed numbers. It is this antagonism of interest which is at the root of the great speed difficulty, and the reason why I have not quoted any relation of the Warneke numbers to my own is that the former were usually used as mere trade terms, and did not indicate an actual test of the batch. In my own work of speed quotation, my point of view is entirely that of the *user* of the plates.

Watkins and Wynne Speed Standards.—My standard (adopted in 1890) is that plate speed 1 is such that with F/8 and 2 seconds Actinometer time (best summer light) it requires for an average subject 2 seconds exposure.

The Wynne standard was at first the same as the above, but plate speed 1 was afterwards called F8, and the standard time of darkening the actinometer is not the same as in the Watkins Meter. The following table gives equivalent Watkins and Wynne speeds:—

Watkins		Wynne	Watkins		Wynne
11	=	F 22	90	=	F 64
16	=	F 28	130	=	F 78
22	=	F 32	180	=	F 90
32	=	F 39	250	=	F 111
45	=	F 45	350	=	F 128
65	=	F 56	500	=	F 156

Some plate makers in quoting Wynne numbers omit the F, which leads to great confusion.

Objections to Actinometers.—It is sometimes objected that the sensitive paper actinometer is not a perfect instrument, and that it does not of necessity indicate the volume of the particular light to which the plate is sensitive. It is quite true that *any* actinometer must be a compromise as regards its color sensitiveness. The steadfast paper is decidedly orthochromatic in character. The ordinary silver chloride paper was used in early actinometers, and Abney was the first to point out that the silver salt in an actinometer should be the same as the plate for which it was used, and, therefore, a bromide of silver paper should be used. He advised tannin to make the paper darken quickly. But a nitrite has generally been used. This, while generally satisfactory in other respects, darkens to a pink shade in damp weather instead of the usual blue-grey, and is hygroscopic. Consequently, it was quite impossible to issue a painted tint which should always agree. Always carrying the meter in the pocket minimized the difficulty, and my method of using a blue glass or film over the paper practically removed it. By the way, the blue glass does *not* lengthen the time required to darken the paper. The blue glass baffles those who attempt to make the match one of *color* instead merely of darkness.

The new steadfast paper contains no soluble salt of any kind, and is, therefore, far less hygroscopic—it always darkens to the same colour.

The Watkins actinometer standard (and therefore the speed of plate standard) has never been altered.

No actinometer paper is equally sensitive over a wide range of damp and dryness. It is doubtful whether any other actinometer, other than a darkening paper, would be equally suitable for popular and pocket use.

Another objection to the use of an actinometer is that to be perfect it ought to test the light *reflected* from the subject and not that falling upon it. This theory is quite a false one. I have tested it in this way:—Two plaster casts were taken, one white, the other a dark brown. The light reflected from each was carefully tested by an actinometer under equal circumstances, all extraneous light being carefully screened off. Plates were then exposed for times proportionate to the actinometer times. As I expected, the two negatives were identical in density, and would, if printed, give false ideas of the *difference* between the white and brown casts.

Time Development for Bromide Paper.— After testing the relative speeds of 6 different brands of ordinary bromide papers, I exposed pieces behind the same negative to a gaslight for times inversely proportionate to the speed.

I then developed each for four times the appearance of the image, and although some of the papers were quick developers and others slow, the six prints were identical. It does not appear at first sight that time development will be an advantage for bromide work, as few workers find any difficulty in developing to whatever depth they want, the surface image being so plain to sight.

But the following aspect of the question is worth consideration:—Exposure is *everything* in bromide work, and there is little compensation (as for negatives) in development. If with slight under exposure you force development to get enough density, a general harshness results, while if with over exposure you cut down development to avoid a dark result, you get a flat picture.

I think, therefore, a higher standard of excellence will be attained if the *one* influence of development be kept uniform by timing with a settled factor, and that all attention is then concentrated on the *exact* exposure. The exposure will then decide the darkness of the print, and gradation will remain uniform. The factor for a particular developer (it does not vary for different papers) must be found by each worker for himself; it will be much shorter than those for negatives. I found 3 right for one Metol-Hydroquinone developer and 4 for another, but I do not intend undertaking the test of the innumerable developers published. One-third or one-fourth the factors given in negative list may serve for first trial.

In timing bromide prints, it is not convenient to have to consult a watch or even a dark room clock. The best plan is to take in the hand as many coins as the multiplying factor, begin to count on pouring on developer, and as soon as the image appears put down a coin and begin to count again. Do this again when the appearance number is reached a second time, when put down the second coin, and so on until the last coin is put down, when wash off developer.

Time Development for Lantern Slides.—The arguments I have used also apply to lantern slides, and here again I think the time method will prove useful. I am unable to quote factors. They would be higher than for bromide paper, but perhaps a trifle under those for negatives.

The Metol-Hydroquinone developer is quite efficient for making cold toned lantern slides. For a slightly warm tone developer, I have found the following excellent.

Thermo-Pyro. No. 1	1 dram.
Thermo Metol-Quinol No. 1	2 drams.
Thermo Pyro No. 2	3 drams.
Water to	3 ounces.

Perhaps a better lantern plate developer for warm tones is made by adding to each oz. of the normal pyro soda developer 20 minims of 10% sol. of Ammonium Carbonate, and 10 minims of 10% solution of Ammonium Bromide.

Autochrome Development.—Although Messrs. Lumières' first instructions were most painstaking and explicit, it is not surprising that in a process of such delicate complexity there were some weak points in them. The most important was the fixing of an exact 2½ minutes for first development. This time ought to be varied according to temperature, and five minutes for their developer is not too much in cold weather.

Their present method "for correctly exposed plates" with a developer of standard strength is exceedingly simple, but here again they give an unchangeable 2½ minutes, as if a uniform temperature is practicable.

I strongly advise that their solutions (at standard strength) be adopted, and my Autochrome Time Thermometer be used. This at 60° indicates the $2\frac{1}{2}$ minutes and corresponding times for other temperatures. This $2\frac{1}{2}$ minute thermometer is also right for Paget Colour Plates. With this and the Colour Plate Meter for exposure I think a maximum proportion of successes will be attained.

Messrs. Lumières' "Methodical Development" plan is one of factorial development slightly modified by commencing with a weak developer. It introduces the danger of exposing an extremely colour sensitive plate to a dark room light, but is better than always developing for $2\frac{1}{2}$ minutes.

Personal.—I regret that I cannot undertake to answer queries, give advice, or test plates or developers for *individual* photographers.

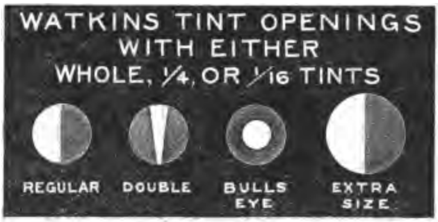
Business. —Enquiries respecting the working of the Watkins meters and methods, if addressed to the Watkins Meter Co., and with postage enclosed, will receive careful attention. But this does not infer a liability to fit factors, times, or temperature coefficients to developers. Speed enquiries are only answered by the speed card, for which $1\frac{1}{2}$d. for card and postage must be enclosed. The shilling yearly subscription to speed card will save much trouble.

Timing by Paper Slip.—Professor Bryan has improved on the Watkins time slip plan by adopting slips of gaslight paper, dipping in the developer in full daylight for an inch for a few seconds and then dipping deeper and counting the seconds required for the second tone to attain the same (maximum) darkness as the first. This makes allowance for changes in temperature and energy of developer. The observed time is multiplied by a factor to get the total time of development for the plate, which is then developed in darkness. The factor would vary for different plates. The method is suited for tank development and is worth a trial.

It is obvious that the factor will vary with the development speed of the plate and the speed card code will help in this respect.

A user of the method for studio work has found the factor with metol-quinol to vary from 18 to 30.

Tint Opening for Actinometers.—When I first devised a meter in 1890 I laid down the following ideal—that equal areas of darkening paper and painted tint of equal shapes should be compared, surrounded by black paper, and with no other tint to disturb the eye. I adopted the single circle divided by the tint. In accordance with a demand for a lighter tint for interiors one was afterwards added in the same opening, but I have always considered that it confuses matters. I have now—after submitting it to many users, returned to the simple single tint, other tints to be carried on a separate dial (now provided to calculate from the smaller actinometer time) and put in the meter as wanted. This "regular" tint I considered more accurate in matching than the bull's-eye (used in most early meters), which however is supplied when required, as is also the old double tint, and an extra large tint which some prefer. All these without extra cost for substitution. The old triple tint is taken off the list (although supplied if wanted) as it is most confusing to the eye.



Special Dials for Bee Meters.—Both the ¼ and $\frac{1}{16}$ tints are now furnished on special dials (F numbers only) which calculate direct from the actinometer times of these tints.

Users of the cheaper single lens cameras (not marked with F numbers) have now available special Bee Meter dials marked only with the stops for the particular camera. This adds greatly to the efficiency of Brownies, F.P.Ks., and Ensignettes.

Jottings

Exposure does not vary with the size of an object on the screen.

Learn to count seconds accurately by practice with a metronome or watch or pendulum of meter. A convenient way to "nought *and* one *and* two *and* three," etc. Commence with "nought" at the moment of uncapping. Most people's seconds are half-seconds.

In making enlargements for hanging, remember that 12 x 10, or at the outside 15 x 12, is more effective practically than larger sizes.

A spare sensitive plate makes a fair temporary substitute for a broken focussing screen. Shield it from much light.

Two pieces of cardboard, each the shape of a carpenter's square (L shape), and longer than the largest print made, are invaluable in judging how much to trim a print. They can be placed over the print to show a rectangle of any size or shape.

In trimming prints, each side is usually cut with one stroke of the knife. There will be a much smaller proportion of jags and tears if an uncut bit be left at the commencement of the stroke to take the "pull" of the knife. This is cut through with a second stroke.

A modern shape of ale glass used by publicans is just the thing for dark-room use. It is plain with concave outline and bell shape top easy for pouring. Both the 6 oz. (pony) size, and the usual 8 or 9 oz. size should be bought (at any glass shop which supplies public-houses). They may be marked at the 2 oz. and 4 oz. level with a file, the marks being filled in with brunswick black. At the same time ask for one of the old-fashioned publican's glass sugar crushers (cost 1d.) which is most useful for stirring and hastening the dissolving of solid substances.

Plenty of washing is a good general motto for photographic operations, but there is an exception when transferring a plate from a pyro developer to the fixing bath. The plate should then be only rinsed, as long washing leads to a general stain in the film.

To find exact focus of a lens. Focus any object at such a distance that its image (sharp on the screen) is exactly the same size as the object iself. Measure from focusing screen to the object, and one-fourth this distance is the focus of the lens.

If a short exposure (say ⅛th second) is desired, and a shutter is not available, it is difficult to cap and uncap with sufficient rapidity without shaking the camera. But if the cap is loosened and a piece of black card or brown paper slipped between it and the lens, the cap being removed, the card can be rapidly raised and lowered by hand without shake. Or the folded focussing cloth can be held in front of the lens before drawing the slide. Probably half the subjects usually taken with a fast shutter would be better done in this way.

"Take a long focus lens for a mountainous district." This advice is copied from one to the other, but has little foundation. The writer likes a long focus lens and always carries one, but amongst the Alps he found it less often wanted than at home.

Select *the thinnest* lantern slide binders; thick paper will not lie flat unless moistened back as well as front.

To take a pair or stereoscopic negatives with an ordinary ¼-plate camera. Expose one negative, then move the whole of tripod and camera 3 inches to the right, in the following way:—Cut a stick or strip of paper 3 inches long, lay this on ground against one of the tripod legs, and move the leg 3 inches to the right; do the same with the other two legs. The second negative can then be exposed. This plan can only be followed with still objects, and fairly level and even ground.

Any lens is wide-angle if used to cover a larger plate than it is designed for. Don't buy a wide-angle half-plate lens, if you have a quarter-plate lens, which, when stopped down, will cover the larger size.

The most generally useful focus for a lens is found by measuring from corner to corner, the plate to be used.

A lens may be called wide-angle when its focus is as short or shorter than the length of the plate.

The lid of a P.O.P. tube makes a good lens cap.

For negative storing, grooved boxes are an abomination when number increases. Get a supply of paper negative bags, and label each with date, name of place and subject. Then sort out alphabetically (taking name of place, rather than subject) and provide a separate pigeon-hole or division shelf for each letter of alphabet. Any negative can then be easily found. Stack on edge.

"Print dense negatives in the sun, thin ones in the shade." Quite correct as a matter of convenience, for it is difficult to stop at the right moment if printing thin negatives in the sun; but as a matter of fact any negative, whether dense or thin, gives exactly the same result, if printed in sun as if in shade, provided both are carried to same depth.

In photographing small objects (natural history, flowers, etc.) requiring an even back ground, a sheet of glass is very convenient to support them, the back ground being at some little distance behind or beneath, all shadows are thus avoided. The glass may be vertical and the objects cemented to it (a mixture of wax and canada balsam warmed is a useful cement for the purpose), but is more convenient to place the glass horizontal and lay the objects on it, the camera being supported lens downwards.

Pinhole photographs occupy a peculiar field of their own, and if suitable subjects are selected, and a fairly large plate used, the results are most pictorial, especially for hanging on a wall. Many photographers, who do not look for a minute detail in a crayon or water-colour drawing, cannot forgive the want of sharp detail in pinhole pictures, but surely this is narrow class prejudice.

Lantern slide makers, who work negatives half plate or larger, can generally find among their negatives some with all the interest confined to a long narrow strip, and suitable for printing panoramic lantern slides from, suitable transparent plates (6½ x 3¼) can be had, and they form a most welcome change in a lantern evening. A common push-through carrier is used.

"Rubbing down" with methylated spirits is a most useful means of reducing harsh and over dense negatives. The wrong way to do it is to spread a piece of wash leather on the finger, moisten with spirit, and rub away at the dense part. The right way is to cut the end of a bottle cork flat, spread wash leather or flannel on this, moisten with spirit, and rub evenly backwards and forwards the whole of the negative, the high lights will be evenly planed down as it were, and the shadows not reduced.

For local reduction and removing halation the "Baskett" reducer has a good reputation. It is rubbed on with a bit of flannel, and made by mixing in a jar 2 oz. Terebine (from oil shop), 2 oz. salad oil, and the contents of a 2d. tin of Globe Metal Polish.

It is well to think twice before adopting a large size plate or camera. The 7½ x 5 size is the largest which the average man can carry without undue fatigue for a day's work. It also happens that this is about the smallest size which is important enough to frame. The favourite half plate is not quite large enough to "hang" with satisfaction.

Optical reasons make it far easier to do hand camera work with short focus lenses (and, therefore, small plates) than with longer focus lenses. For instance, a 4-inch focus lens (F/8 gives everything beyond 17 feet in equal, whereas a 7-inch lens has to be 52 feet from an object to get it in focus with everything beyond.

When removing finger stains with aid of hot water, nail brush, and soap, try holding both fingers and brush *under water* during the process; it is much more effective than the usual plan. Brooke's soap is efficient in bad cases.

To find a point of view for photographing a building somewhat surrounded by trees or building. Walk round it and note those positions (probably on higher ground) which *you can see*. It follows that a person (or camera) in such a position could also see you. This is often useful in a street or square of which it is desired to get a vantage point.

A set of labels, for the formulæ in this book, to cut out and paste on the bottles, will be found at end of advertisement pages.

Extremely rapid plates—used as advertising baits by makers, run after by beginners, and avoided by old hands.

Carbon is a delightful and not all difficult printing process. The manipulation is not a delicate matter, and the choice afforded in the print both as regards colour and surface is a great advantage.

Requisites for carbon printing are few:—the carbon tissue (get it ready sensitised a dozen at a time) temporary support, final transfer paper, a squegee, an actinometer or print meter, 6d. cake of special wax, the photographic dishes used for other work (turn one bottom up for a squegeeing surface), and a few sheets of blotting paper.

The Bee Meter makes an efficient Print Meter for carbon printing. Test the light in seconds and call that number of minutes *one tint*. An average negative will print on carbon tissue in 3 tints. Example: Meter darkens to its tint in 10 seconds. Ten minutes will be one tint, 20 minutes two tints, and so on. Each negative can be labelled the number of tints it takes.

For a cover for developing dish take a piece of thick brown paper 3 inches larger each way than top of dish and press down over dish, pinning each corner to keep its dished shape.

Learn to work in the dark with plates, developer, and appliances. It is quite easy to work by feel if things are arranged to hand beforehand, and with modern thermo development a dark-room light becomes more and more unnecessary, while it was always a poor and inefficient help.

In printing on Autochrome three-colour carbon tissues, the exposure has been found to be as follows: Blue, 8½ times the meter time in seconds; Red, 6 times; Yellow, 5 times. These times are obviously much shorter than ordinary carbon printing.

To develop trial pieces of rollable or flat film, it can be secured to a glass plate by small bits of adhesive rubber plaster, such as is sold in tape form.

Sheaths to hold flat films for tank development are not so practicable as may appear at first sight, as most films are now coated at the back with gelatine which must not be in contact with a metal back during development.

Coins, especially old ones, should not be photographed direct, but from a mould or impression. To make such a mould soak two-ivory visiting cards in water until soft, lay two or more coins between them, place the whole between two pieces of thick felt and put under pressure for a few minutes in a screw letter copying press. The impressions are then photographed (not less than full size) with a top side light, the moulds being upside down, and a negative resulting. A print from this negative will appear in relief, although a hollow mould is photographed.

Backed and anti-halo plates can be reckoned the same speed as unbacked. The modern soluble backing of most makers need not be wiped off before tank development, even in the horizontal Watkins tank. But there are a few exceptions.

The new lens "cap that fits," not only serves for several different sizes of hoods, but uncaps without shaking a light camera. Its pear shape makes it firm when pressed downwards and loose when slightly lifted.

To make up No. 1 solution of Thermo Pyro-Soda by the method introduced by the British Journal of Photography. Dissolve the sulphite and metabisulphite in 8 ounces of warm water, and boil the solution for a few minutes. When cooled down add the 160 grains pyro, and then make up with water which has boiled to a total bulk of 10 ounces. The altered proportion of metabisulphite (1 to 8 of sulphite) and the expulsion of air by boiling confers keeping qualities. If stored in small bottles filled to the neck, larger bulks can be made up for keeping.

The Watkins Meters and Methods

Testimony

(Additional to that in previous editions).

"I have used your system of tank development with your Time Thermometer for 3 years in India, and find it the only successful method that one can use there."—B.B.

"Not long ago there appeared in an illustrated Sunday magazine an article stating that it was rare to get one good autochrome out of ten plates but our experience has been that four perfect colour pictures can be made from every box by timing the exposure exactly as indicated by this Colour Plate Meter."—"American Photography."

"If your meters were good enough for Scott and Ponting at the South Pole, they must be good enough for 'Old England.'"—G. F. P.

"I have a ¼ plate tank which I am more than pleased with and would like to develop my 'Baby Sibyl' negatives with a Watkins too."—F. S. G.

"I have found your Manual packed with more real and helpful information than any other handbook of photography."—D. M. R.

"I have used your meter for the last ten years and always recommend it to anybody who asks me about exposing a plate or film."—G. F. R.

"I consider the Indoor Meter is worth its weight in gold."—T. F.

"I am so pleased with the tank you have sent me that I would like to develop all my plates with such tanks."—C. M. (Col.)

"I admire your style, it is plain, straight, unvarnished and fearless, with a total absence of bias."—A. McC.

"I may say that I have been using your thermometer, tank, and Bee Meter for some little time now (for ¼ plates), with such regular and consistent results that development has lost all its interest in the way of wondering what will turn out, the results being so invariably excellent."—D. M. M.

Testimony—*Continued*

"I obtained one of your thermometers while in India a couple of years back, also a tank, and have always been an advocate of your excellent methods. While again on the voyage I actually had some difficulty in convincing our Skipper I did a bit of photography without a dark room and used merely a changing bag for a few minutes."—F.W.T.

"I have used one of your Standard Meters for very many years and it has always proved a most valuable and reliable assistant."—T. W. T.

SOUTH POLE

June, 1910.

"Your meters having served me so well in so many lands, I have decided that each sledging party on the Expedition shall have one, in the use of which I will instruct them."

Dec., 1912.

"Your exposure meters proved as reliable in the Antarctic regions as they have always been. In the extremely puzzling light of the Polar regions I should have been quite nonplussed at times without them. I have brought back many hundreds of negatives, the correct exposure of which they were the means of indicating."

Daily Mirror, May 21st, 1913.

"CAPTAIN SCOTT was particularly keen. At first he would let me work out his exposures for him, for photographic exposing in these regions is a very difficult business, and then he would go and develop the plates himself. But he soon progressed beyond this stage, and with the help of an exposure meter he worked out his own exposures. There was never any 'hit or miss' work about any of our photographic operations down south, as an opportunity once missed seldom or never came again. As it was necessary that one should make sure of every plate or film exposed WE ALL USED EXPOSURE METERS."—H. G. PONTING.

(Photographer in Captain Scott's Expedition).

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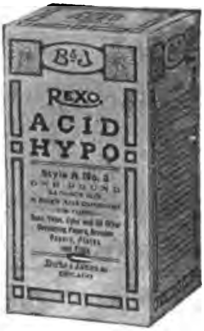

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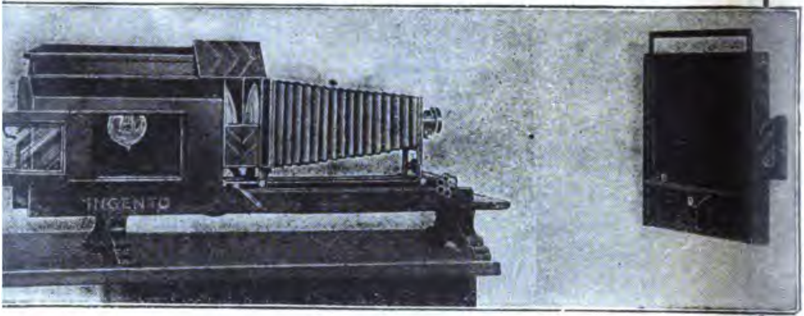

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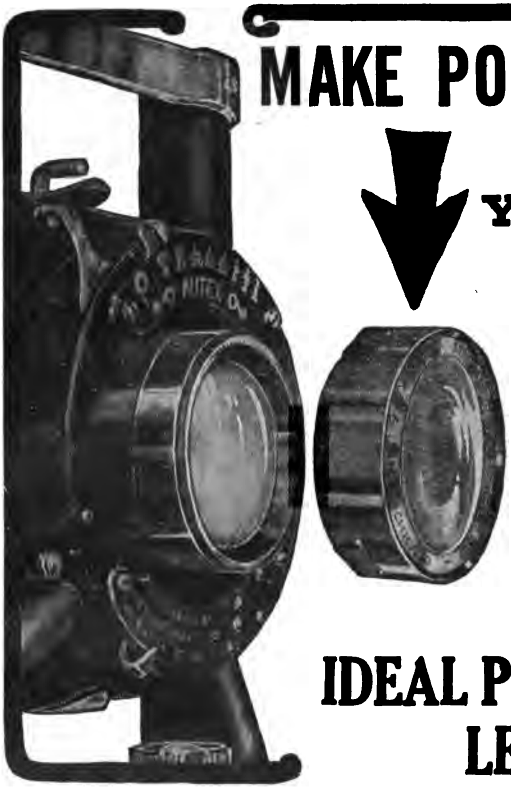

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